PERCHERONS IN FARM PASTURE

MODERN
FARMERS' CYCLOPEDIA
OF
AGRICULTURE

A Compendium of Farm Science and Practice on Field, Garden, Fruit and Orchard Crops, and the Care, Feeding and Diseases of Farm Animals

by

EARLEY VERNON WILCOX, PH.D., LITT.D.
Agricultural Writer and Investigator
Formerly Farm Management Specialist, United States Department of Agriculture; Director Hawaii Agricultural Experiment Station; Professor of Biology, Montana State College; Chairman Agricultural Jury of Awards, Lewis and Clark Exposition

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PREFACE

THIS VOLUME is based on agricultural research and farm practice. The observations and experience of skilled farmers subjected to systematic tests in scientific investigations in experiment stations, state and federal departments of agriculture, agricultural colleges and special research foundations, have solidly established an enormous mass of reliable information on all vital problems which the farmer has to meet. The gist of this fund of knowledge is here presented in readable form with such conclusions as seem warranted by the author's studies and travels during the past 45 years in all important agricultural regions of the United States and foreign countries.

The results of the innumerable experiments in agricultural problems as reported by investigators are often at variance or even flatly contradictory. This fact has been constantly borne in mind in preparing the present volume, and need cause no concern to the thinking farmer. Farmers do not all agree on the exact details of pig rations, nor on how often to cultivate corn, nor on the choice of corn cobs or hickory saw dust for smoking hams. Experiments show that there may be several ways of arriving at the same results. The conditions of no two experiments can be made exactly alike. The intelligent farmer will, therefore, quickly discern in studying the reported conclusions from any test what suggestions may be profitably adopted for incorporation into his own farm practice.

In 1904 the author, with the cooperation of C. B. Smith, summarized the results of agricultural experiments with crops and live stock up to that date, and again in 1908 with reference to live stock. In the intervening years farm science and farm practices have been fundamentally improved and in many fields revolutionized by the constant stream of new discoveries. The importance of vitamins and minerals in rations, and methods of sanitation has come to the fore. The modern technique of commercial poultry raising is of very recent years. New methods of combating insects and fungous diseases of crops, and of controlling diseases of live stock are in use. The relative importance of breeds of live stock and varieties of cultivated plants is constantly changing. Centers of production are shifting from one part of the country to another. The general picture remains much the same but the details are forever fluctuating. These facts have been considered in presenting the material herein as a fresh statement of agricultural science.

An effort has been made to adjust the length of treatment of each subject in some degree to its relative importance in the field of agriculture as a whole, even when the crop is chiefly grown in Texas, California, Michigan or New York. To a specialist in cranberries that subject may seem to outweigh apples or oranges. But in Yakima or Los Angeles such an idea is anathema.

So many original sources have been drawn upon that a formal listing of all authorities would be quite beyond the limits of this prefatory statement. Credit has been given frequently for specific information throughout the text of the book. For illustrations acknowledgment is made to the Extension Serv-

ice, Bureau of Animal Industry and Bureau of Entomology of the U. S. Department of Agriculture, and to Everybody's Poultry Magazine. It is a special pleasure to testify to the courtesy and helpful suggestions of Mr. George E. Eiermann, President of the Orange Judd Publishing Company, during the course of the preparation of this volume. It has been a joint undertaking with Mabel Owens Wilcox who has typed the manuscript, read proof and helped in indexing.

E. V. Wilcox.

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PART I

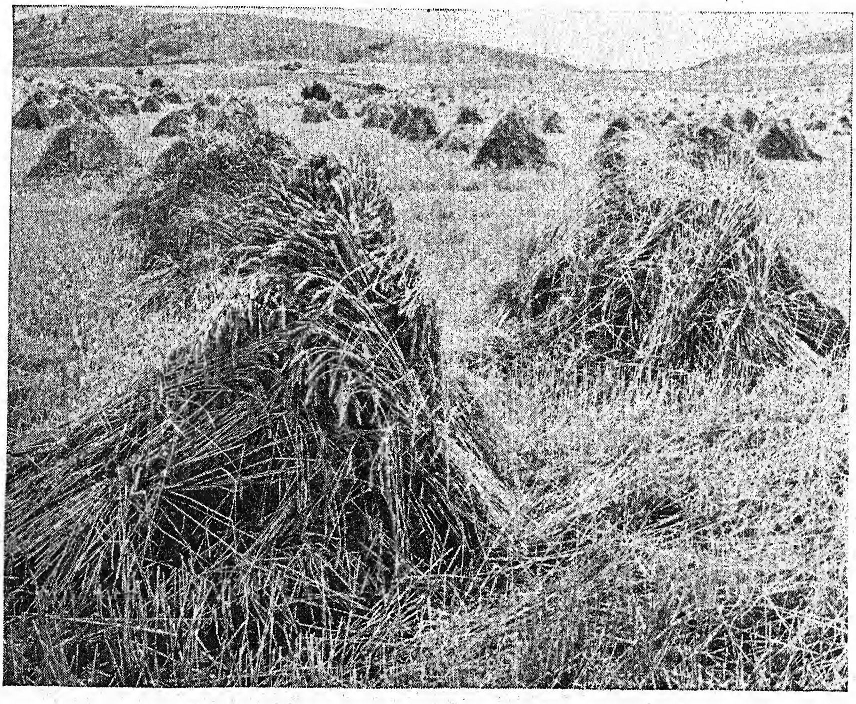
FIELD CROPS

MODERN
FARMERS' CYCLOPEDIA OF AGRICULTURE

AGRICULTURE

Farming may be a profession, a trade, a mode of life, a practical application of scientific discoveries, a hobby, a part-time diversion or a mere dilettante and haphazard adventure, depending upon the attitude of the person who owns or tills the soil. We commonly understand by the term farmer, however, an individual who seriously and intelligently devotes his thought and effort to the problem of deriving a living and a share in the joys of life from the cultivation of a tract of land. To secure a maximum return in farm products and human satisfaction he will find use for all the wisdom and practical knowledge which may be culled from the whole gamut of man's achievements from the beginning of time to the present day. Nothing useful that he may have learned will come amiss on the farm. A bit of botany, animal anatomy, bacteriology, soil physics, physiology of plants, weather, surveying, blacksmithing, rope making, carpentry, care of sick animals, sanitation, nutritive value of feeds, crop rotation, farm planning, methods of marketing—all these and many other skills will come in handy.

Progress in farming and improvement in farm methods follow experience and day by day study of the problems as they



WHEAT IN THE PALOUSE REGION

GRIMM ALFALFA IN NORTH DAKOTA

arise. Fortunately there are many directions in which the farmer may look for outside help. Farm journals, particularly those of State or regional coverage, carry many helpful suggestions in their columns. The State Experiment Stations and the U.S. Department of Agriculture prepare bulletins on a great variety of farm topics. Perhaps the best guide when in doubt about the precise details of the best methods of procedure is to cultivate the acquaintance of the most successful neighbors within easy reach. Success in farming depends upon knowing how to do the little things which the crop or live stock needs and at just the right time.

Using the present volume as a springboard it is hoped the reader may proceed by personal experience and detailed enquiries along the way to still greater success and to a still deeper joy from the profession of farming, the oldest and, despite all quibbles to the contrary, the nearest altogether satisfying profession to which man has turned. The only indispensable requirement is a genuine love of outdoors, nature, plants and animals. The rest can be learned.

FIELD CROPS

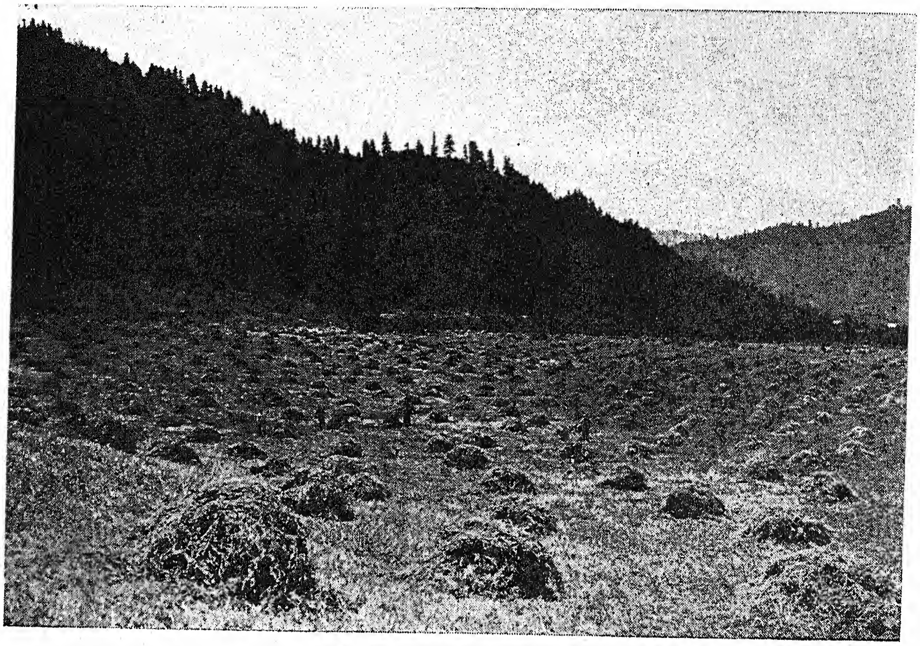
ALFALFA or LUCERN (*Medicago sativa*)

Alfalfa is the most important legume used for hay and forage in the United States. Introduced into California in 1850 it has gradually spread over the country until it has found a foothold in every State, the national total of the crop being 12,000,000 acres. Its popularity is increasing particularly in Iowa, Missouri, Minnesota and other east-central States. Alfalfa perhaps thrives best in arid or semi-arid regions under irrigation, but recent experience indicates that its further spread is limited only by climate and soil conditions. Failure to secure a satisfactory stand of the crop in eastern and southern States is usually due to neglect of observing the requirements. Alfalfa thrives best in good sandy loam soils with easily permeable subsoils. It is a notoriously drouth-resistant crop. The tap root goes down in search of water and soluble plant food to great depths, even thirty feet or more where possible, as in lake-bed soils of the Western States. Where an impenetrable hard pan or water-table is found within 3 feet or less of the surface

CAPPED COCKS OF ALFALFA HAY

the tip of the tap root decays and the plant languishes. Alfalfa is a crop which is never happy with wet feet. It requires an abundance of moisture but the soil must be well drained. The roots can not stand in water. Experiments in the Western States under irrigation have shown that alfalfa absorbs 750 tons of water by the roots to be transpired through the leaves for the production of each ton of cured hay.

frail, tender and easily smothered out by rank and rapidly growing weeds. Inadequate preparation of seed bed has been responsible for many failures with this crop. The ground should be prepared well in advance of planting. In the northern and eastern States alfalfa may best be sown in the spring as soon as danger from heavy frost is past. In Mississippi and other southern States good stands have followed seeding from September 15 to October 15, while spring plantings have yielded poor results. Alfalfa should be sown alone and not with wheat or oats as is the customary practice with clover. The quantity of seed per acre varies from 10 to 25 pounds depending upon the method of sowing. The heavier seeding will be needed if sown broadcast. If drilled, 15 to 20 pounds should be enough. After drilling the ground may be lightly harrowed across the drill rows. A thick sowing is better if the aim is to secure an excellent quality of hay than if the crop is grown for seed.



ALFALFA IN OREGON

Calcareous soils are well adapted to alfalfa but nearly any good porous soil may serve. In cold heavy clays and wet lands it may give less profitable returns than clover, and may live only one year in such locations. Deep plowing and thorough preparation of the soil before planting is important. The land should be freed of weeds as completely as possible. The plant spends the first year largely in getting solidly established, and full crops should not normally be expected till the second or third year. But when once established paying crops may be expected for years. Many western alfalfa fields have been cropped continuously for 30 years or more and are still going strong.

It will be a disappointment and sheer waste of time to attempt to grow alfalfa on weedy ground. The young plant is

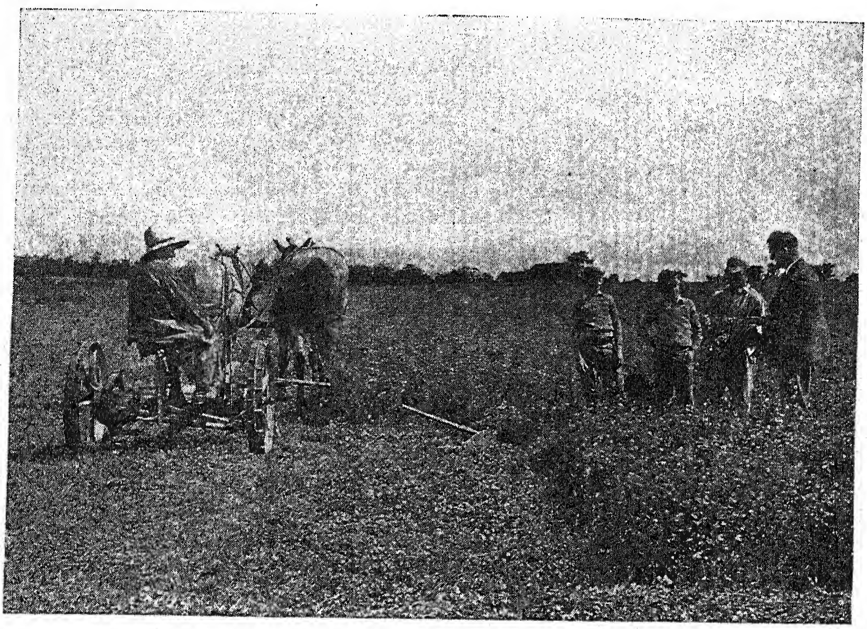
If rapid growth takes place a light crop of hay may be cut the first season. At all events the fields should be mowed high once or twice to keep down weeds and prevent them from seeding. First year alfalfa should not be cut in northern

States too late in the fall. If allowed to form five or six leaves before freezing weather sets in, the crop will withstand the rigors of winter much better.

In the South alfalfa succeeds best if grown after some hoed crop as a method of checking weeds. Soybeans for hay may be used for this purpose to precede alfalfa on rich soils, or the soybeans may be plowed under on less fertile land as a preparation of the seed bed. Broadcasting is not advisable because of the prevalence of crab grass, foxtail and other weeds. Good results have been obtained by drilling in rows 16 inches or more apart and keeping the rows cultivated the first season. Recent tests in Mississippi indicate that the alfalfa drill is quite satisfactory, the only necessary precaution being not to cover the seed too deeply. When a wheelbarrow seeder was used it was found advisable to sow half the seed one way of the field and the rest across the first drilling.

In the Rocky Mountain States, up to elevations of 7000 feet as in the San Luis Valley, alfalfa seed may be sown as soon as settled spring weather arrives. It is essential, however, that the upper two feet of soil be moist enough from irrigation or recent rainfall to furnish the water required for the growth of the plant till the tap root reaches a depth of two feet. From then on the crop is fairly well fortified at least against ordinary dry spells. For while the tap root may go down to great depths in search of water, more than 65 per cent of the fibrous roots are distributed in the upper two feet where the chief absorption of water and soil nutrients occur.

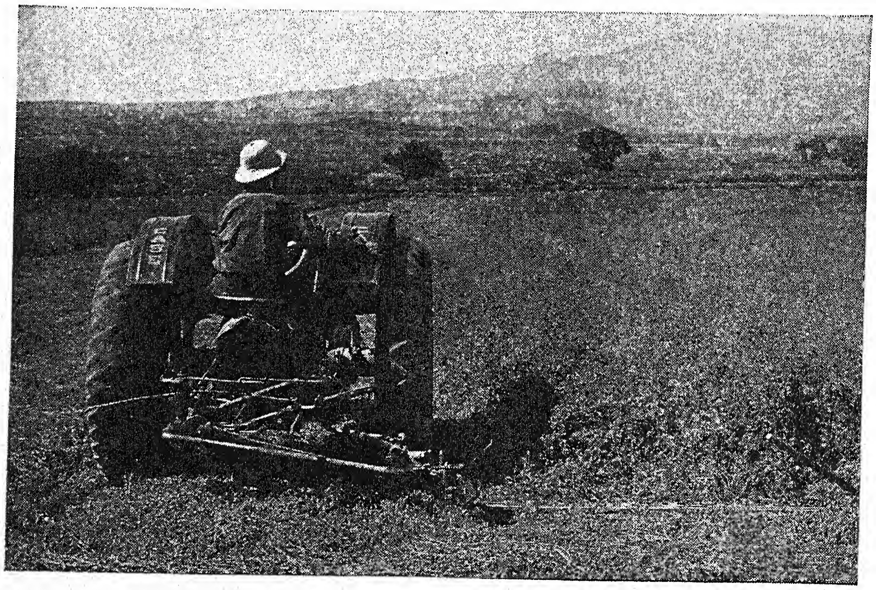
The water requirements of alfalfa are higher than for most crops. This is due to the rapidity of its growth, the number of its cuttings, the length of its growing season and the tonnage of the total crop. Alfalfa is commonly cut 2 or 3 times annually in the east and 6 to 8 times in California. The yield of cured hay per acre ranges from 3 to 8 tons. Temperature and rainfall of course affect the amount of irrigation water required. Thus in Bozeman, Montana, 3.7 feet of water was applied for a yield of 4 to 7 tons of hay. At Scottsbluff, Nebraska, 26 inches of water produced 5 tons of hay per acre. Corresponding amounts were found desirable in other irrigated regions. Obviously natural rainfall must be depended upon where irrigation is impossible.



HARVESTING ALFALFA IN NEW YORK

Harvesting. The crop is cut for hay just as the first flowers are coming into

bloom. At that time it is tenderest, shows the highest ratio of leaf to stem, and contains the greatest amount of digestible nutriment. Cut in the bud stage, or when about one-fifth of the flowers are in bloom, the leaves constitute over 60 per cent of the total weight of the plant. The amount of protein is higher than at other stages of growth and the palatability is at the maximum. As the crop matures beyond that point the stems become woodier green color will be lost, leaving a brown smelly product instead of the crisp, green aromatic U.S. No. 1 alfalfa hay. The difference in market value may be $7.00 a ton or more with almost no demand at all for the low grades of hay. Injury from rain or heating or improper curing greatly lowers its value as a dairy feed which is the chief market for standard alfalfa hay, while even the mule may balk at eating moldy alfalfa.



MOWING ALFALFA

and less edible and the leaves may yellow or fall off so that at full bloom the leaves make up only 50 per cent of the weight, and at seed stage only 33 per cent. Meanwhile the protein declines from 38 per cent to 10 per cent. In the eastern and middle States the crop may be cut in the forenoon, spread with a tedder, then raked into windrows, as with clover, and after a little further drying, be removed to the stack or barn. In any case the less it is handled the better, as the leaves easily rattle off if too dry. If, however, it is put up too moist, it will heat, mildew and lose much of its feeding value. The proper handling of alfalfa hay, like thousands of other farm practices, must be learned by experience. It cannot be set down in a formula. Rain is perhaps the worst risk. If weather forecasts are available it is foolhardy to cut alfalfa with the prospect of rain falling upon it. The

Seed Production. In Colorado the first crop is considered best for seed production, while in the eastern States the second crop is more desirable because better filled. For seed the crop is cut when the pods are dark brown. No rain should be allowed to fall on it. From 5 to 10 bushels per acre is an average seed yield. Many western growers cut the seed crop with a binder. For the production of seed alfalfa blooms must be cross pollinated. The honey bee is the most important insect for that function. It pays to keep bees near the fields. The yield of seed is thereby at least doubled. Incidentally alfalfa flowers furnish an abundance of excellently flavored honey.

Feeding Value. Alfalfa stands high in the list of feed stuffs. It is rich in protein which is converted by animals into blood, muscle and bone, and when fed with corn, oats, corn fodder, roots and

other materials rich in fat and starch forms one of the best rations for all kinds of farm stock. Pork cannot be made cheaper than by allowing hogs the run of alfalfa pasture. And for growing cattle, horses and sheep there is no forage better than alfalfa hay. In the east the crop may not stand heavy pasturing and some care must be exercised in its use. Cattle and sheep not accustomed to grazing on young alfalfa are liable to bloat especially if it is wet with dew. But hogs and horses are not subject to that trouble.

Like most legumes alfalfa is a valuable soil builder. It enjoys the power of gathering nitrogen from the air and storing in root nodules. Its deep tap roots bring fertilizing elements from the subsoil and place them near the surface within the reach of other crops. When plowed under the stems, roots and leaves add more humus and nitrogen to the soil and leave it in a more friable condition for the vigorous growth of other farm crops.

The varieties of alfalfa are legion and thousands of tests have been made in all the States to determine which are the most prolific and to learn which varieties are especially resistant to drouth, winter killing, alkali, diseases and other particular conditions. The beginner, before venturing upon alfalfa production, may best inquire about the most recent experience with varieties by consulting a neighbor or applying to his State Agricultural Experiment Station.

Enemies: Root Rot (*Ozonium auricomum*) attacks a great variety of plants, including alfalfa, cotton, apple, peach, apricot and other trees. It attacks alfalfa near the surface of the ground and extends downward, ultimately killing the plants. The decaying roots are surrounded by a mesh of brown strands. The mature stage of the fungus is not known. The disease spreads in all directions through the soil and it is therefore recommended that a trench be dug around the center of infection. Some writers urge the application of salt or kerosene to infested soil in order to kill the fungus. Rotation of crops is the most successful remedy, and grasses should be used as the alternating crop, since they are not attacked by the fungus.

Leaf Spot (*Pseudopeziza medicaginis*) is the most destructive disease of alfalfa, and occurs in almost every locality where alfalfa is cultivated. The plants are usually attacked after the first year's growth. Irregular brown spots appear on the upper surface of the leaves, and later the spots contain black centers. The disease spreads by spores floating in the air. Frequent cutting of the crop sometimes prevents the distribution of leaf spot. New fields of alfalfa should be planted as far as possible from infested fields. The disease survives the winter and may remain in the same field for many years. The fields may be burned over each fall in order to destroy diseased leaves.

Several species of cutworms feed on alfalfa and at times occur in such numbers as to cause serious loss. They may be dealt with as recommended under Onions. Alfalfa is also attacked at times by the Army Worm, Locusts and Leaf Hoppers.

Dodder (*Cuscuta epithymum* and *C. trifolii*) are parasitic plants which frequently infest alfalfa fields, particularly in the west. The stems of these plants are leafless yellow-like threads, which twine around the alfalfa stem and rob it of its juices by means of sucking roots. The dodder spreads very rapidly, forming tangled masses, and soon completely chokes out the alfalfa. Small infested areas should be mowed before the dodder blossoms, covered with straw and burned where it lies. Where whole fields are affected, they should be plowed and planted to some cultivated crop for a year or so. As the plant is an annual, it will die out in one year if not allowed to go to seed. The usual method of introduction of this pest through alfalfa seed can be prevented by thorough screening, since dodder seed is only about one-half as large as alfalfa seed and can be screened out. In no case should alfalfa seed from an infested field be planted.

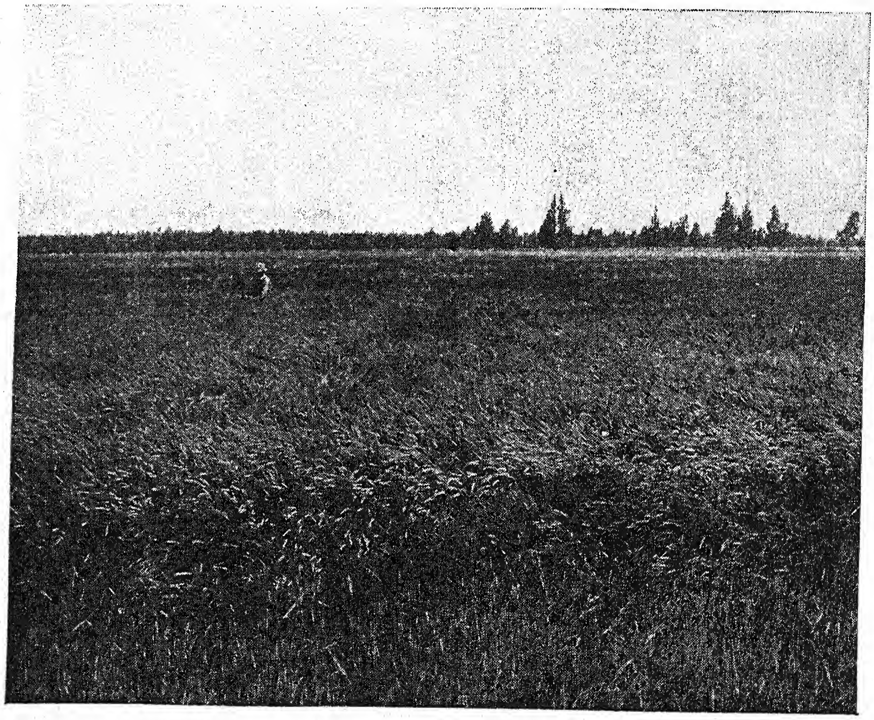
BARLEY

Barley is one of the most widely distributed cereals, and has been cultivated since remote antiquity. In Egypt and Palestine it was the common feed for cattle and horses, and there was the miracle of "five barley loaves and two small fishes." The early Greeks and Egyptians used barley for making bread and beer. The grain is grown in the U.S. for stock feed and malting, about 75 per cent for stock feed and 25 per cent for malting. A premium is paid for good malting barley but the market is so easily oversupplied that the trend is toward production for feed. The acreage is increasing for that purpose. Forty years ago the main use for barley was for malt. More than half of the crop of 12 million acres is grown in the North Central States with

Minnesota leading. California takes second place.

The quality requirements for malting barley are so strict as to make success with it a specialty. Definite U.S. standards have been established. Certain varieties must be used such as Manchuria, Odessa and Velvet. No variety, however, will produce malting barley in unsuitable localities. Most of it is grown along the Upper Mississippi, but small areas here and there are known from New York to the far west. As pointedly presented by the Department of Agriculture, barley for malting must be sound, clean and of high germination. Seeding should be earlier than for feed barley. The land should not be too fertile since the straw may be too tall and weak and thus cause lodging. Fully ripened grain is of supreme importance. Unless the grain is flinty hard and fully ripe the proteins cause a cloudiness and other troubles in beer making. Frequent rains injure the color for malting. Broken kernels due to careless threshing lower the value. Excellent malting barley has been grown under irrigation in the mountain States and in California. But irrigation is a tricky matter. There is no general formula for it. Its right use varies from season to season. Barley kernels increase in size till fully ripe. Withholding of water for too long a period before harvesting may result in shriveled grain, while too much water at that time may result in lodging and a soft kernel.

The production of feed barley is subject to far fewer hazards. "It may or may not be of the varieties or qualities desired by maltsters. It may be grown solely for feed or may be the result of an unsuccessful attempt to grow barley acceptable to maltsters. Barley grown for feed need not be of inferior grain."



BARLEY FIELD IN OREGON

Barley is raised under a wide range of weather conditions on many types of soil. In Texas it is not adapted to sandy soils nor to areas of excessive rainfall. It is usually seeded in the fall since it does not thrive in hot weather. The two chief barley sections of Texas are the central part of the State and the Panhandle, the average yield per acre being about 17 bushels. Wintex and Texan are 2 superior varieties originated in the State.

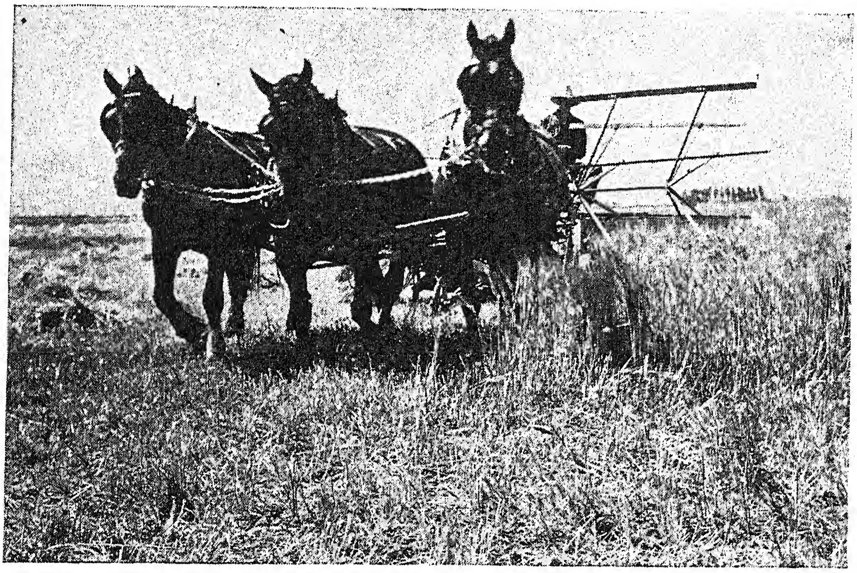
Practically all the barley grown in Texas is used as feed for stock. It has proved also to be an excellent crop for winter cover to hold the soil in periods of heavy rains. The crop may be used for hay or green manuring.

The required cultural practices for barley are practically the same as for other small grains. In Texas the crop may follow corn or cotton in a rotation, but if it follows other small grains volunteer plants from the previous crop may cause a bad mixture of seed.

In western Texas land to be sown to barley in the spring should be left rough through the winter to prevent undue wind erosion. The usual practice in central Texas is to seed 6 to 8 pecks per acre in plantings between September 15 and November 15. Later plantings may well be delayed till January 15, except in west Texas where seeding may be done between February 15 and March 15.

Barley is harvested almost exclusively with combines in west Texas, and with binders or the power take-off type of combines in central Texas.

In discussing recent shifts in the popularity of barley, H. V. Harlan of the Department of Agriculture concludes that most of the changes have been outside of the malting areas, and that increases in general have been for feeding purposes. "On favorable soils barley yields more pounds per acre than any other small grain. It fits in well with the system of agriculture in the areas adapted to the crop. It may be fed to all kinds of livestock, and is constantly increasing in popularity with dairy farmers. It is almost equal to corn as a feed. It produces firm pork. The value of barley for feeding depends largely on its weight per bushel. Barley weighing 48 pounds per bushel has almost the same value as corn. The barley kernel is too hard to use for feeding without some preparation. Grinding is the common treatment in the central and eastern States. When grinding barley the machine should be so set as merely to crack the grain rather than pulverize it. In the west much of the grain is rolled."



BINDING BARLEY IN NEVADA

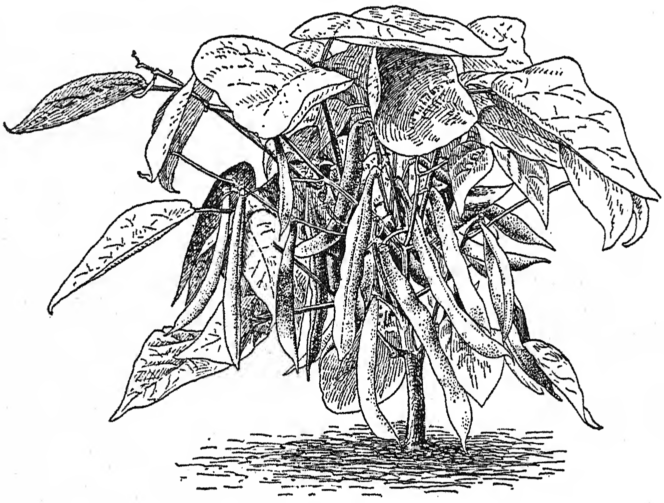
Some 5000 varieties of barley have been tested by the Experiment Stations and Department of Agriculture. There are seed-growers' associations in most States from which certified seed may be obtained. The State stations can furnish reliable information on the relative value of varieties for local growth as shown by experiment year by year. Velven, a smooth-awned variety, originated in Utah in 1934, is giving much promise. The cultivation of barley is on the increase in that State. One-fifth of the farmers of Utah raise barley, about 6 to 10 acres per farm. Barley has been found to produce more

feed units than any other small grains which in part accounts for its rapid expansion in acreage. The variety, Velvon, shows a high degree of resistance to the covered smut disease. This and 2 other kinds of loose smut and scab are the 4 most serious barley diseases. The best treatment for these diseases consists in dusting the seed with ceresan, a poisonous mercury dust compound, which should be handled with great care. Barley may also be attacked by rust, joint worm and Hessian fly. (*See remedies under Wheat.*)

BEANS

Beans is a general term commonly used to include a considerable variety of related legumes. Soy beans, cowpeas, which are more akin to beans than to peas, and horse beans are discussed under their own names. The common field beans are considered here. The acreage of dry edible beans produced in the U.S. has ranged from 900,000 to 2 million acres since 1920, varying up and down in recent years with a total of 11 to 18 million 100-pound bags from year to year. Michigan is the banner bean State, followed by California, Colorado, New Mexico, New York and Idaho.

The first world war greatly promoted the production of beans in U.S. from 11 up to 19 million bags. Production was stimulated most prominently in New York, California, Colorado, Idaho, Nebraska and Oregon. Simultaneously a shift in the relative importance of varieties took place. In New Mexico, Colorado and Arizona the Pinto dominated the bean fields reaching nearly 95 per cent of the total crop. In California the Pink, Small White and Black Eye came into greatest prominence. The Great Northern, a white bean supposed to have been developed by the Mandan Indians, acquired some notoriety when 40 carloads of it were marketed in Billings, Montana. The large increase in the use of the Pinto bean was the direct result of an active propaganda. The average yield of the Pinto is about 350 pounds per acre and the crop requires 90 to 100 days to mature. Pintos at once became popular also in Kansas where a buff or brown type was raised, and where they were threshed with a flail or a bean huller. The Pinto has proved about as good for all purposes as the common navy bean. The consumers' color preferences are, however, not easily predictable. White beans are often preferred to brown.



FIELD BEANS

Pintos are planted about 3 inches deep in rows, and in the western States are cultivated merely enough to control the weeds. The usual bean harvestor cuts off 2 rows and throws them together. The beans are at once put into small shocks and stacked about 10 days later. The small white bean seems to be best for the Utah farmer because it outyields other varieties, ripens more uniformly and shatters less in harvesting. In Washington preference has been shown for the Small White, Large White and Mexican. The bean yield in the far western States is

lower than that of Michigan and New York, chiefly for the reason that a large proportion of the western bean acreage is on dry farms where in drouth times the farmers may realize from nothing up to 200 pounds per acre. But the various by-products of the bean industry are being used more efficiently. One large cattle company in California has been feeding cattle a mixture of bean straw and molasses at the rate of 10 pounds of bean straw to 1 of molasses, with the result that cattle relish the mixture and make rapid gains in weight on it.

The Michigan Station considers that "Michigan can grow field beans more advantageously than any other State. Although the acreage in 1942 was down somewhat from the record 1941 level, the yield was such as to make the 1942 crop the largest ever harvested in Michigan. The two factors most effective in maintaining high yields are the use of the Michelite variety and the plowing under of a legume for the bean crop. Sweet clover seeded in fertilized small grain and plowed under the next spring when 8 to 12 inches high, is the ideal forerunner to a good bean crop. Turned under alfalfa or alfalfa-brome grass mixture also makes for big bean yields. The Michelite variety is disease-resistant, easier to harvest, entails less screening losses and is superior in quality and appearance."

Culture of Field Beans. Field beans require for their best growth well-drained clay loam or gravelly loam of medium fertility. On heavy soils, or those containing large amounts of humus or manure, beans will mature later and tend to the production of vines rather than seed. If low lands must be used for the bean crop they should be ridged. The seedbed should be well prepared by plowing and harrowing. On lighter soils, the use of moderate amounts of well-rotted barnyard manure will be found one of the most effective fertilizers. The bean belongs to the legumes and is, therefore, able to draw part of its nitrogen from the air. Potash may be applied in the form of wood ashes and phosphoric acid in the form of superphosphate of lime. Experiments at the New York State Station indicate that potash is probably not so important in the growth of beans as was at one time believed, while on poor soils in Georgia plants receiving nitrogen gave the largest yields in every instance. At the New York Cornell Station phosphoric acid in the form of South Carolina rock gave the best results. With bush beans at the Rhode Island Station, the addition of nitrogen in the fertilizers applied was without benefit. Ordinarily it will not be necessary to add nitrogen to the fertilizer formula for field beans.

Beans are easily killed by frost and if planted too early the seed will rot. Nothing is gained by planting before the ground is warm, and in the north this is not much before the first of June. The crop develops rapidly under favorable conditions. Beans may be planted in hills or drills. When planted in drills the rows should be 2½ to 3 feet apart and the beans 3 to 4 inches distant in the row. If grown by the hill method the hills may be 15 to 18 inches apart, with from 4 to 5 beans in each, the same width rows being used as for drills. During the season frequent shallow cultivation will be required, not only to furnish plant food and keep down weeds, but for the important purpose of preserving soil moisture. Care should be taken not to cultivate the beans when they are wet, as the dirt sticks to the leaves and spots them.

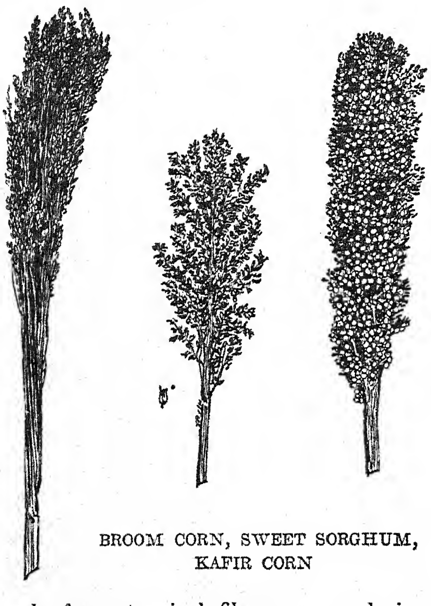
Where large crops are grown, the plants are pulled when the pods are ripe, by running a plow along one side of the row with a special kind of point which cuts off the vines just below the surface of the ground. Men follow with pitch forks and throw the vines together in small piles, where they are left for a day or more to cure. Machines are now on the market that pull 2 rows of beans at a time and throw them together. When the crop is very weedy or machinery is not available, the vines are pulled by hand. Care needs to be taken in curing not to allow the vines to get wet, as this discolors the beans and lowers their market value. When the vines are thoroughly dry they are run through a thresher with special concaves, or threshed out with a flail. They are then further cleaned by running through a fanning mill, after which all discolored beans, as well as stones, dirt, etc., are picked out by hand. This latter work is usually performed by children, women or other cheap labor. The yield of different varieties varies greatly in different localities. Tests should therefore be made of a number of varieties to see which is best suited to the locality in question. In bean growing districts when all beans are cheap they may be used for feeding. Ordinarily, beans are too costly for stock feeding. They are rich in protein. To sheep they may be fed whole, uncooked, but only as part of the ration; for hogs and other stock they should be

cooked and it is advisable to mix them with such material as corn meal.

For the diseases and insect pests of beans *see under Garden Beans* in Part II.

BROOM CORN

This non-saccharin sorghum of uncertain origin, introduced into the Connecticut Valley in 1797, has been migrating westward since that time in search of cheaper land, pausing temporarily in the Mohawk Valley of New York and the Scioto Valley of Ohio, and today being centered in Oklahoma, Colorado, Kansas, New Mexico, Illinois, Texas and Missouri, with a total area of 300,000 acres and a production of about 40,000 tons of brush. As pointed out by J. H. Martin of the Department of Agriculture, the U.S. acreage of broom corn is not increasing. Vacuum cleaners, dust mops and brushes made from tropical fibers are replacing the old-fashioned brooms and any increase in consumption seems very improbable. Under most favorable conditions broom corn yields about 600 pounds of brush per acre in Illinois, while in the semiarid western center of production the yield is only 200 to 300 pounds.



BROOM CORN, SWEET SORGHUM, KAFIR CORN

Broom corn will grow in practically any locality adapted to corn or wheat. The small demand for the crop limits its production. Almost any farmer who so desires could doubtless raise broom corn for home-made stable or kitchen brooms. Broom corn may occupy in farm rotations the same position as cotton, corn or grain sorghums, following some sod crop. It is harvested earlier and does not need so many cultivations as corn or cotton, but otherwise the soil requirements, seed bed preparation and other tillage operations are much the same. Most broom corn is planted in May in Illinois, in June in Kansas and in April in the Lindsay section of Oklahoma. At Tucumcari, New Mexico, June 15 has proved to be about the right date for planting. "The rate of planting is of extreme importance in securing a good quality of broom corn. If the stand is too thick the brush will be short and spiky, and if too thin it will be long, coarse and crooked. In the humid broom corn areas the plants should be spaced rather thickly, about 3 inches apart in the row, or 60 to 75 plants per rod. In the western district a thinner spacing is desirable, about 6 to 9 inches between plants, or 25 to 35 per rod."

Harvesting and Curing. Broom corn is usually harvested for brush when the seed is in the dough stage. Experienced growers, however, are not unanimous on this point. At harvest time the stalks of each 2 rows of standard varieties are bent down diagonally toward each other in such a manner that the bent parts support each other in a nearly horizontal position. The bend in the stalks is made about 3 feet from the ground. The crossed stalks form a kind of platform or table on which the heads, with about 6 inches of the stalks attached, are laid after being cut. The heads should be left on the tables about a day to dry out. The color of the brush is injured by rain or heavy dew. When possible it should be cured entirely under a shed; but if the green brush is brought in directly from the field it must be cured in thin layers, which requires considerable shed room. If the brush is cured a day in the sun it can be put in much deeper layers in the shed. The heads of dwarf varieties of broom corn are pulled by hand directly instead of being bent over and cut off as with standard varieties.

"A vast amount of hand labor is required in harvesting broom corn. About 10 to 14 days of man labor are needed to harvest, cure, thresh and bale a ton of cured brush. A ton of brush contains 40,000 to 70,000 heads, and each brush must be cut or pulled separately by hand. The work must be done promptly and requires large crews." Formerly the seed was removed by holding the brush between revolving cylinders like those used

in threshing machines. Threshing is preferably done before curing. It is important that all the seed be removed and the cylinders of the modern power threshers should not revolve faster than 1500 per minute. Otherwise too many of the fine branches will be torn off. The brush is cured either in ricks or sheds. Ricks are cheaper but expose the brush more to weather damage. Rain may discolor the brush and lower its market value.

In the western broom corn district where threshing is done after the crop is cured, the seed is of considerable feeding value for livestock, particularly hogs and poultry. Broom corn fodder is woody and of little value. Evergreen, Black Spanish and California Golden are the chief varieties of the standard group, while the dwarf and whisk types of broom corn include 4 other varieties in common use.

Broom corn is subject to Kernel smut which may be controlled by dipping the seed before planting in a solution of 1 pound copper sulphate in 5 gallons of water. The insect pests of broom corn are for the most part the same as those which attack corn, and similar remedies may therefore be applied.

BUCKWHEAT (*Fagopyrum esculentum*)

Buckwheat, a native of the Volga Basin came into western Europe before the 17th century and was apparently brought to America with the pilgrims who learned in Holland of its use in making pancakes. Since 1900 production in the U.S. has ranged from a million acres down to about 340,000 acres recently, and from 15 down to 6 million bushels. The leading buckwheat States are Pennsylvania, New York, Minnesota, Ohio, West Virginia and Michigan. Its principal use is for griddle cakes and for feeding chickens. Buckwheat also has a recognized value as a green manure, and particularly as a weed eradicator. Buckwheat fields when harvested are notoriously free from weeds. It is often grown chiefly as a honey plant on account of its long blossoming period and the large nectar content of the flowers. The honey is dark in color but of a strongly specific flavor. Even in the States of large production buckwheat is commonly restricted to small special areas. One of the round top hills in Chautauqua County, N.Y., is locally known as Pancake Hill on account of the prevalence of buckwheat. The average yield is about 18 bushels per acre, but yields of 40 bushels have been obtained on fertile land.

Soils. Buckwheat will grow on land where most other crops will starve, but for good yields a fertile, well-drained sandy loam is desirable. It will not do as well on heavy clays or on wet lands. Usually only the poorer lands of the farm are sown to buckwheat, the better lands being reserved for the more exacting crops. It is a valuable plant to turn under as a green manure on poor sandy lands where clover fails to catch; for while it adds no fertility, it makes humus in the soil, thus increasing its water holding capacity for the better growth of some succeeding crop.

Seeding. Buckwheat is a tender plant and easily killed by frost. It grows from 2 to 2½ feet high and requires only about 70 days to fully mature from the time the seed is sown. On account of its rapid development it is frequently used as a catch crop. In the South buckwheat may be planted any time from May to September, but in the Northern States it is usually sown between June 15 and July 10. The seed is sown from 2 to 3 inches deep, either drilled or broadcasted. The latter is the more common method. From 2 to 3 pecks are sown per acre. The better the land, the greater should be the amount sown. The seedbed should be prepared in the same manner as for any of the other grains. When planted for green manure, 2 crops may be grown in a season. The plant should be plowed under when grown for this purpose about the time it begins to blossom. It makes a fair soiling crop.

Fertilizing. In fertilizing the buckwheat crop, heavy applications of barnyard manure or other nitrogenous fertilizers should be avoided. Potash and lime are the elements most in demand by the plant and these can best be supplied in the form of unleached wood ashes. They should be applied at the time the seedbed is prepared at rates of 20 to 50 bushels per acre, depending on the poorness of the land. Moderate amounts of well-rotted barnyard manure may be profitably applied on soils deficient in humus. Buckwheat does well after grass. Comparing the demand on the soil made by buckwheat with oats, Russian studies have shown that in order to obtain even a low yield of oats the soil must contain much more nitrogen and somewhat larger quantities of plant foods than are required for a crop of buckwheat.

Harvesting. The blossoming period of the plant extends over 3 weeks or more, so that the grain ripens unevenly. The best crop of grain will be secured if the

crop is cut soon after the first seeds are ripe. If delayed longer than this, many grains shell out and are lost. The plant is quite succulent, and has to be cured, therefore, by setting up in small unbound or loosely bound sheaves in the field. The crop is threshed direct from the field without stacking. It must be handled carefully and as soon as dry. If allowed to stand in mass it quickly gathers moisture and is damaged. For this reason it is not usually stacked or placed in mows unless in layers with straw or like material between.

The experiment stations have given little attention to buckwheat. "It is not usually included in a definite rotation. It yields fair crops on land too poor for corn or wheat, and may be grown year after year on the same land with little or no effect. A good rotation for much of the area suited to buckwheat is: first year, alsike or red clover; second year, buckwheat; third year, potatoes; fourth year, rye, oats or wheat seeded to clover. Combines have been used in recent years in some sections for harvesting buckwheat. This machine reduces the losses from shattering but may break up the green juicy stems, and does not separate the green immature seeds."

Varieties. The list of varieties of buckwheat is not long. Seedmen usually advertise but 3 varieties: the Common or dark colored grain; the Silver-hull, which has light colored grain; and the Japanese. At the Massachusetts Station all these varieties developed in about 74 days. Silver-hull gave the best yield followed by Japanese and then the Common. Within recent years the Japanese variety has come more and more into prominence and is especially commended for the Western plains.

The Iowa Station states that it has had the most experience with the Silver-hull and common black buckwheat, but has grown the new Japan buckwheat near the old varieties for 2 years and has found it much superior to either of them in several important respects. "It is larger and stronger, and stands up better during storms than the old kinds, and its seed are also larger. But the characteristic which places it far ahead of other varieties, is that of setting full crops of buckwheat in dry, hot weather. It can be sown much earlier than the Silver-hull or black varieties, so as to avoid losses by early frosts." All varieties are about equally valuable for flour.

Feeding. The whole grain of buckwheat is considered a valuable poultry feed, more especially for chickens. It is much more generally used in France for this purpose than in America. The general claim is made that feeding buckwheat promotes egg production early in the winter season, and gives a good flavor to the meat. The outer black hulls of the grain have only very slight food value, but the kernels inside this covering which form the buckwheat middlings are rich in protein and have a high feeding value.

A good grade of buckwheat middlings proved superior to a mixture of corn and bran, or of cotton seed and linseed meal, for dairy cows at the Vermont Station. The middlings were fed with hay and silage. They made cheaper milk and considerably cheaper butter than the cottonseed-linseed ration, and gave 3 per cent more milk and 6 per cent more butter at 2 per cent less cost than the corn and bran ration. Buckwheat middlings should be fed only in limited quantities, as cattle do not take to them kindly and they may slightly injure the quality of the butter.

Buckwheat bran consists of a mixture of both hulls and middlings. It is fed to milch cows and believed to be conducive to a large flow of milk. The charge that buckwheat by-products make a white tallowy butter and pork of low quality is probably without foundation, providing the feed is not given in excess. As a single grain ration it tends to the production of soft pork and lard. Canadian experiments show that ground buckwheat is not quite so good for pigs as ground wheat, though the difference in favor of the wheat was but 6 per cent. When the straw is well cured it makes a good fodder for sheep and cattle. If spread on the land it rapidly decays and makes a good fertilizer.

CANAIGRE (*Rumex hymenosepalus*)

This plant grows wild and seems particularly adapted for culture in the sunny winter climate of the Southwest from Oklahoma to southern Utah and south into Arizona, New Mexico, Texas and southern California. It will grow in other parts of the country but the roots do not seem to develop so well. It is gathered and grown for the tannin which it contains.

The plant resembles sour dock in appearance. It attains a height of 1 to 3 feet, the leaves vary from 2 to 16 inches in length and from ovate to lanceolate. The seed is from 1/8 to 1/4 inch long and 3-cornered like buckwheat. The valuable

part of the plant is its tuberous root, which in general appearance much resembles sweet potatoes. These are borne in clusters of 2 to 15 in an upright position 3 to 12 inches below the surface of the ground. The tubers are 2 to 4 inches long and weigh from 2 to 20 ounces each. The tannin content of these roots has been found by many analyses to vary between 8 and 38 per cent and to average for the older roots about 20 per cent in the air dry condition.

A sandy loam soil is most suitable for the culture of canaigre. The ground requires about the same preparation as for potatoes. The plants may be propagated from seed, but the usual method is from the roots planted 3 to 4 inches deep. Young roots are preferred for this purpose by the Arizona Station. When these are planted at 1 foot intervals in rows 3 feet apart it requires about 900 pounds of 1-ounce roots to plant an acre, or about a ton of 2-ounce roots. Cultivation should be given sufficient to keep down weeds and maintain a loose soil mulch. Wild canaigre makes its growth during the winter and early spring, and by June 1 has seeded and the tops died down. The roots remain dormant during the summer and do not start into growth again until after the winter rains. In Arizona the best time for planting is between September and March, but in Texas the planting season occurs from May 15 to September 15. The roots are harvested after the full period of growth and when in a dormant condition. A yield of 10 tons of green roots per acre may be expected if the crop is dug at the end of the first season, or from 15 to 20 tons if dug the second or succeeding season.

The leather industry demands tannin in such large quantities that canaigre can hardly compete with other sources of tannin such as gambier, mangrove, wattle bark and quebracho.

CASSAVA (*Manihot* spp.)

This is a starch-producing plant, native of tropical America but adapted for cultivation in Florida and some of the Gulf States. It is commercially grown in Florida for the production of starch. The roots, or more properly the enlarged underground stems, constitute the valuable portion of the plant. These are from 1 to 3 inches in diameter, and from 1 to 6 feet long, and analyze about 20 per cent starch and 3 per cent sugar. The portion above ground assumes the form of a luxuriant many-branched shrub from 4 to 6 feet high and as far across.

There are 2 varieties of cassava, the bitter and the sweet. The bitter (Manihot utilissima) contains hydrocyanic acid stored in its roots, and is poisonous. It is grown mostly in the tropics, is distinguished by having 7 divisions of its palmately formed leaves, and is the variety from which tapioca is obtained. The sweet variety (Manihot Aipi) shows but 5 or less points to its palmately divided leaves and is non-poisonous. This is the variety grown in Florida. Relative to its value in Florida, a recent bulletin states "that, all things considered, cassava comes nearer furnishing the Florida farmer with a universally profitable crop than any other which he can grow on equally large areas. It can be utilized in more ways, can be sold in more different forms, can be more cheaply converted into staple and finished products, and can be produced for a smaller part of its selling price than any other crop."

The vast areas of pine lands in that State are considered perfectly adapted to the culture of this crop, which thrives best on moderately fertile sandy soils. It is claimed that it will withstand drouth better than any other staple crop. Portions of the region from North Carolina west to Oklahoma and Texas are considered adapted to its culture. It requires about 7 months' immunity from killing frosts to come to full maturity.

Culture. The land for cassava should be deeply and thoroughly prepared as for corn, the rows plowed out 4 feet apart each way, and the seed or canes dropped and covered at the intersection of the rows. The crop is not an exhaustive one. Fertilizer experiments at the Florida Station show that cassava does best on the poor sandy soils of the station when fertilized with a mixture of 150 pounds of cottonseed meal, 62½ pounds of acid phosphate, and 37½ pounds of muriate of potash per acre, applied together, a short time before planting.

The plant seldom produces seed in Florida, and therefore portions of the stems, as in the case of sugar cane, are used to propagate the plant. The entire portion above ground, with the exception of the leaves and tip stems, is used for this purpose, being cut into sections about 4 inches in length. These are preserved over winter by placing the butt ends of the canes at a slight angle in freshly plowed ground, and overlapping them like shingles. When the bed is large enough

for convenience the canes are covered over with straw, hay or moss, and this with a light layer of soil. Thus cared for, the canes will endure perfectly over winter and be ready for planting in the spring. Two canes are dropped at each furrow intersection and are covered by a turn plow or like implement. The first cultivation after the plants are up may be deep. But after-cultivation should be shallow and frequent as for corn. When the plants reach out and cover the ground pretty well cultivation may cease. At this stage, which will occur about the first of August, the Florida Station recommends that a single row of cowpeas be planted in the middle of the rows.

In light soils the roots are easily harvested. The tops are first cut off with a hoe 4 to 6 inches above the ground, and the roots then pulled out by hand, the more tenacious ones being loosened with a shovel. The Florida Station experiments show that, contrary to the usual belief, the roots can be easily preserved out of the ground for several months after harvesting if care is taken to keep them in a dry and reasonably cool place. It is more convenient and usual, however, to let them remain in the ground until wanted for use. The average yield of roots at the Florida Station was at the rate of 6½ tons per acre.

Use. The use of cassava in the production of starch has been spoken of. It is also valuable for the production of glucose and for human consumption and feeding to stock. In feeding experiments with pigs at the Florida Station cassava proved superior to corn, chufas or peanuts for fattening purposes. These results are remarkable and need confirmation. As cassava is a carbonaceous food, rich in fat-producing material, it should always be fed along with more nitrogenous food, such as peas, vetch, clover, etc., to form a more nearly balanced ration.

As a raw material for the manufacture of starch, an acre of cassava yielding 6 tons of roots will give about 2400 pounds of starch, while an acre of corn yielding 40 bushels will give but 1200 pounds of starch, or only one-half as much as an acre of cassava. "It thus appears that cassava is today the cheapest known source of starch, costing at present market values of raw material only about ¼ as much as its nearest competitor."

The Dutch in Java until the Japanese invasion, were leaders in production of cassava flour and tapioca.

CASTOR BEAN (*Ricinus communis*)

This native of Africa is a perennial in the tropics but an annual under cultivation in temperate climates. The chief sources of castor bean are India, Java, Persia and China, and the Mediterranean countries. It is grown to some extent in Oklahoma, Kansas, Florida and Missouri.

This plant is grown to a limited extent as a farm crop in a number of Southern States and as far north as Kentucky. As an ornamental it is grown as far north as Canada. It is sensitive to frost. In the tropics it is more tree-like in appearance, growing sometimes 30 feet high, and perennial. It decreases in size northward and is cultivated as an annual from 4 to 8 feet high. As is well known the castor oil of commerce is obtained from this plant.

A fertile, well-drained, sandy loam is preferred for this crop; but any soil suitable for the production of wheat or corn will give good results with castor beans. Prepare the ground for plowing to an average depth and harrowing thoroughly. Rows laid off 4 to 5 feet each way, with wider spaces about every 6th row to admit a sled or wagon for gathering the beans, is the common method of planting. Six or 8 beans are planted at each intersection and thinned to 1 plant in a hill when danger from cutworms is past.

At the Oklahoma Station, the best results were obtained when the beans were planted every 15 to 18 inches in rows 48 inches apart. The best time for planting at the station was found to be about the middle of April. When planted this early the crop began ripening the third week in July. The best yield at the station was 12.9 bushels per acre.

To aid in the germination of the beans and to secure a more even stand, hot water a little below boiling point should be poured over them, and they should be allowed to soak in this for about 24 hours before planting. Without this preparation they germinate slowly, many not making their appearance above ground for 3 or 4 weeks.

Cultivate level to keep the soil mellow and to destroy weeds as for corn. After the plants are about 2 feet high they are capable of taking care of themselves and grow very rapidly.

The beans are produced in husks or pods on spikes of various lengths. If allowed to get overripe they pop out and the beans are scattered over the field and lost. To avoid this the entire spike should be cut off as soon as the pods begin to turn brown. Each plant bears a number

of spikes which commence ripening in July and continue till frost comes, therefore the field must be gone over a number of times. The cut spikes are thrown in a wagon and hauled away to dry in the sun, either on a board floor or on ground packed hard by rolling. Board floors are best. Boards should be placed around the sides to prevent the beans from popping outside the space allotted them. The spikes should be turned occasionally until all the pods have burst open and the beans left them, when they should be taken away and a new supply brought from the field. Care should be taken not to let the beans get wet, as this injures the quality and lowers the selling value. After each drying the beans should be swept up and run through a fanning mill to clean them; after which they should be stored in a dry place.

After the beans commence ripening the field should be gone over regularly twice a week until frost comes, and all ripening spikes gathered. Frosted beans bring about ½ price, and should never be mixed with good beans, as this lowers the price of the whole lot.

The pods have been analyzed by the Oklahoma Station and found to have about the same composition as good wood ashes. One thousand pounds of castor beans were found to contain 35 pounds of nitrogen, 4 pounds of potash, and 14 pounds of phosphoric acid. The pods gathered with this amount of beans weighed about 800 pounds and contained 13 pounds of nitrogen, 46 pounds of potash, and 1½ pounds of phosphoric acid. If the pods are returned to the soil it will be seen that the castor bean is not a hard crop on the land. A ton of the bean pods has a value as a fertilizer on the farm of about $10. There is no market for them. One hundred pounds of clean dry spikes will produce about 55 pounds of beans and 45 pounds of pods.

Castor beans are usually marketed in the large cities of the East. Prime beans are bright, uninjured beans, weighing not less than 41 pounds to the measured bushel when cleaned. No. 2 beans weigh not less than 38 pounds when cleaned and are valued at 5 per cent less than prime beans. They must be bright and uninjured. Rejected beans are those slightly damaged by rains which weigh not less than 38 pounds per measured bushel. No-grade beans are those badly damaged both by rain and frost or weigh less than 38 pounds per measured bushel when cleaned. The beans contain from 40 to 54 per cent of oil.

CHUFA (*Cyperus esculentus*)

The underground tubers of this plant are known as nuts. They are eaten raw, baked, or made into coffee, and are much in favor in the South as a food for hogs. The tubers are oblong, ½ to ¾ inch long, cylindrical and hard. A crop of ⅓ acre at the Arkansas Station supported 3 hogs, averaging 122 pounds in weight each for 46 days. The gain during this time averaged 66 pounds each, or a total of 198 pounds. The nuts proved much more effective for fattening purposes in this experiment than soy beans, and practically as good as dry corn. When grown for hog feed the hogs are allowed to gather the crop themselves by rooting. The yield per acre in this experiment was at the rate of 184 bushels.

On thin, sandy land at the Alabama Station the green yield was at the rate of 172 bushels per acre, and the yield when dry 115 bushels. At the Ontario Agricultural College the yield of nuts was at the rate of 23 bushels per acre. The plant is grass-like in appearance, and in the North does not flower. Propagation is by means of the tubers. These are usually planted singly 2 inches deep and about 1 foot apart in rows 2½ feet apart. The crop is planted about the same time in the spring as corn and harvested in the fall. At the Arkansas Experiment Station the nuts were planted 12 inches apart in 3-foot rows. In the South the tubers may be left in the ground over winter. Those not gathered in the fall will grow the following spring. The Florida, Alabama, Arkansas and Louisiana Stations all highly recommend chufas as crop for hogs. The nut is sometimes called "earth almond."

A related species known as Japanese nut grass is a pestilential weed in Hawaii and elsewhere, extremely difficult to exterminate.

CLOVER (*Trifolium* spp.)

Among the several kinds of clover the most important are the common red, mammoth red, crimson, alsike and white. They may best be treated separately since their value and special uses are somewhat different. Sweet clover and lespedeza are also loosely referred to as clovers but will be discussed later in their alphabetical order. Wherever clovers thrive they provide a vast amount of valuable fodder and pasture with a relatively high content of protein. Like alfalfa and other

legumes they are soil renovators. If plowed under they still further enrich the soil with humus. Futhermore their roots penetrate deeply and thus improve soil drainage and its moisture-holding power.

Common Red Clover (*Trifolium pratense*) is the most important member of the group. Introduced from Europe into New England before 1750, it has spread pretty generally throughout the country until it occupies about 3,250,000 acres. The largest acreages of red clover are in Illinois, Indiana, Iowa, Ohio, Tennessee, Wisconsin, Missouri, New York, Michigan and Kentucky. It is still the chief leguminous forage crop of the central, northern and eastern States, but meets considerable competition with alfalfa, sweet clover and soy beans. It thrives also in the south but is largely replaced there by cowpeas, and in the western States by alfalfa. Red clover serves for hay, soiling, green manuring, silage or pasture. The plant is a biennial or rarely a perennial of a few year's growth.

Red clover for hay is commonly grown in combination with timothy on about 20,350,000 acres chiefly east of the Mississippi River and north of the Ohio, or ⅓ of the hay acreage of the U.S. Except in the far west, red clover for the past two centuries has played a star role in maintaining soil fertility and in giving us an enviable position in world agriculture. This great service is due to its adaptibility to rotations with other crops. Red clover is indeed the key crop in most three or four year rotations throughout the corn belt. Starting with clover the first crop of which is cut for hay and the aftermath turned under, one or two crops of corn and a crop of wheat may follow, returning then to clover. In many localities, however, the soil has been so badly depleted by long overcropping without legumes that difficulty has been experienced in securing good stands of clover.

The plant reaches a heighth of 1 to 2 feet, and usually produces 2 crops per year, the first crop being cut for hay and the second used for seed or green manuring. Bumblebees are essential to the cross pollination of red clover blossoms, and as the bees are not numerous in the early season the second crop receives the benefit of their visit and the seed development is hence correspondingly greater. The yield of red clover hay ranges from 1½ to 3 tons per acre.

Failures with red clover are often due to poor seed. Imported seed has usually given unsatisfactory results. American grown seed is much to be preferred. Germination tests to determine the per cent of adulteration with weed seed such as dodder, wild carrots, rag weed, etc. are essential. Such tests will also show how much of the seed is of weak or slow germination.

Nearly all crops grow well after clover but the clover itself is not adapted to all soils. It thrives on good, well-drained clay loam. Acid soils should be limed for clover. There is a common belief among farmers that almost any crop will grow where clover thrives. Alsike clover will succeed on clover-sick fields and may show results on soggier land than can be used for red clover. According to A. J. Pieters, former chief of clover investigations of the Department of Agriculture, lack of nitrogen in the soil will not matter in clover production, but there must be lime, phosphorus and potash or these elements must be supplied in fertilizers or in stable manure. Phosphorus is furnished by using 200 or 300 pounds per acre of 16 per cent phosphate, while in soils deficient in potash 50 to a 100 pounds per acre of muriate of potash will suffice. Since the potash and phosphorus content of soils may vary greatly in different fields of the same farm the appropriate treatment can best be determined by experiment. It should be borne in mind that clover not only adds humus and nitrogen to the soil but renders more available for succeeding crops a considerable amount of lime, phosphorus and potash.

Seed and Seeding. Red clover is small. If sown to a depth greater than 2 inches it may fail to grow at all, as shown by experience in Michigan. In the upper peninsula of that State it thrives famously when broadcast and lightly harrowed among the stumps of cutover lands without previous cultivation. From 10 to 15 pounds of seed per acre is the general practice if broadcast, or 6 to 8 pounds if drilled. On heavy lands the seed should not be covered more than an inch but may be 1½ to 2 inches on light soils. In all cases the seed bed must be fine and firm. Loose soil is fatal to the young plants for the reason that it may dry out too quickly. "When the sun was up they were scorched, and because they had no roots they withered away" as in the parable of the sower.

Usually in the northern States clover is seeded in the spring. It is more likely to winter kill if sown in the fall. Many farmers broadcast on the snow in March or April. As the snow melts the seeds

are carried down into the wet soil and get a good start in advance of the dry weather of summer. In Iowa where wheat is seeded down with timothy and clover, the timothy may be sown with the wheat in the fall and the clover seed applied in the spring. If sown late in the spring the ground may be rolled after sowing. Wheat is usually a better companion crop than oats since the latter may shade the young clover plants too much. If sown on wheat fields the clover seed may be broadcast when there are still alternate freezing and thawing. When weather conditions seem favorable half of the allotted seed may be sown in February. Should a good stand follow no more seeding is required. If not, a second seeding may be applied in April. If sowing is delayed till the soil dries it may be well to harrow the ground both before and after. The wheat will not thereby be injured if the teeth of the harrow are set to work not deeper than an inch. Or the seed may be drilled in crosswise of the wheat rows.

Sometimes difficulty is experienced in getting a good catch of clover when seeded with wheat. In such cases, after thorough preparation of the ground, the clover seed may be sown alone at a time of year when drouth is least expected, and lightly harrowed in. During experiments in Michigan, tests were made of sowing clover every month of the year. But only the February, March, April and December seedings were successful. The July seedings failed to sprout till the fall rains started, while all seedings between July and December winter-killed. Whether clover is to be seeded with grain or other crops or alone depends on various considerations. For example the grain may help keep down the weeds, and on foul land weeds may get the better of clover. The grain stubble catches and holds the snow and thus reduces the percentage of winter-killing. On the other hand the companion crop interferes somewhat with the growth of the red clover.

While clover is seeded with a number of grasses, timothy is the chief companion in such combinations. Timothy usually matures about 2 weeks later than clover. The first year's crop will be predominantly clover, the second year about one-third clover and two-thirds timothy, and the third year will show an almost pure stand of timothy. Other mixtures have been tried in various localities. In Oregon orchard grass and tall oat grass mature at about the same time with clover and a seeding is recommended by the Oregon Station of 6 pounds each of clover, oat grass and orchard grass seed per acre. In Illinois clipping red clover in the fall of the first year increased the yield of the second year. This result was attributed to the reduction of the injury from field mice. If clover is seeded alone and not mowed the heavy growth forms a mat upon the ground thus providing an excellent cover for mice during the winter.

Cutting Clover for Hay. Red clover should be cut for hay when in full bloom. At this time it contains the largest amount of nitrogenous material in the most valuable form for food. The largest amount of dry matter is found in clover at the end of the blooming period, but it is poorer in the valuable nitrogenous compounds at this time, besides being more woody.

In making hay great care should be taken to preserve the leaves, since these contain, according to the Minnesota Station analysis, two-thirds of the precious albuminoid matter of the plant (exclusive of the roots)—the constituent which gives clover its high feeding value. As soon as the leaves are thoroughly wilted the clover should be raked up and put into small piles to cure. In about 24 hours, with good, clear weather, the piles may be drawn into the barn or stacked. According to the Oregon Station the hay at this time may be a little tough and apparently too wet to go into the barn; but if there is no rain or dew upon it, it will suffer no harm if packed close in the hay mow. The hay should be allowed to cure in the barn with the doors shut, on the same theory that it is desirable to keep air out of the silo.

A program in the hay field is sometimes as follows: Commence cutting in the morning as soon as the dew is off. With hay averaging 1 to 2 tons per acre, no tedding is required. With a heavier crop the hay is either turned by hand or the tedder is run over it as soon as the top of the swath is well wilted. By 2 o'clock the hay cut in the morning will be ready to to rake into windrows and put into piles. In good, hot, sunshiny weather all the morning hay cut up till 10 o'clock will be ready to go into the barn direct from the windrows that same afternoon. That cut later in the day is generally raked into windrows and put up into small piles to further cure over night. The latest swaths cut may be left till the following day before raking. That piled up in the afternoon will be ready to go into the barn

the following morning as soon as the dew is off and the outside has become thoroughly dry. It is always desirable to draw all the hay the same day it is cut, if possible, for if rain comes over night it makes a blackened hay of poor quality. Should rain come after the hay is cut, but before it commences to wilt, no harm is done whatever; and in "catchy weather" farmers frequently run the mower while it is raining so that it may be rapidly cured when sunshine comes.

Bright green clover hay cannot be made unless the crop is cut before the leaves turn brown. The leaves make up only 40 per cent of the weight of the plant but carry about two-thirds of the protein. Late-harvested clover hay requires a longer time for the stems to become dry, and more of the leaves are lost by shattering. If the hay is left in the windrow, too long sun-bleaching reduces its feeding value as well as its palatability and market value. Rain or sweating from stacking or baling too soon have similar effects. Foreign material, such as stubble, cornstalks or weeds, in clover or timothy hay, lowers its value for feeding since such stuff is rejected by livestock and left in the manger. A thin stand of clover almost always results in low-grade hay since it has a high weed admixture. In short, hay is an exceedingly perishable crop and can be secured in prime condition only by observing strictly all requirements. Black, moldy hay is no more palatable or salable than rotten apples.

Clover Silage. Clover is frequently put into the silo. In fact, as a silage crop it is second only to corn, and surpasses clover hay because of its succulence and palatability. Many leaves and the more tender parts of the plants which are the richest in food value and which in hay-making are lost, are also preserved. For the purpose of silage making the clover should be cut at the same period of growth as for hay, but should be put into the silo while it is still green and before it is wilted. Even if the dew is on or if it is wet with rain it is satisfactory for silage. It should be run through a cutter, since when put into the silo whole it lies too loose, thus permitting the admission of air, which is the main cause of silage spoiling. (*See Silage.*) The cut clover should be well packed down in all the corners of the silo so that it is air-tight everywhere. Clover packs better if the silo is deeper than for corn. The fact that clover silage can be made in rain or sunshine and is fully or even more valuable than clover hay appeals to many farmers as one way of avoiding the anxiety of hay-making, and at the same time securing a quantity of excellent forage.

Cutting for Seed. As before noted, it is the second crop of clover which is used for seed. This is because the heads of the first crop are seldom well filled out. For seed purposes clover should be cut when the clover heads or blossoms are well browned or ripe. The clover may be cut with a mower, raked up and put in piles to cure as for hay. It should not be drawn into the barn or stacked until fairly well dried out. The better way is to cut the clover with the reaper or binder. By this method it is not dragged over the ground so much and less seed is lost by shelling out. An average yield is 1 to 2 bushels per acre, though 5 to 6 bushels are sometimes obtained.

Clover Hay for Stock. Clover hay contains more nitrogen than timothy or corn fodder, and practically as much as barley, oats or corn. It is therefore well suited as a roughage for all growing animals. Experience in feeding shows that it is pre-eminently suited as a fodder for sheep and cattle. It makes a more dusty hay than timothy, and is therefore not so well liked by stockmen as a forage for horses. Dusty clover is believed to conduce to the heaves in horses. Clover should form, therefore, only a part of the roughage fed to horses. Sheep and cattle fed on clover hay require less grain in fattening than where fed on a roughage of grass, cornstalks or straw. Cut steamed clover hay is often fed as a green food for poultry in the winter.

Clover pasture is excellent for all animals. Hogs make good gains on it. Care should be taken when sheep and cattle are first turned on clover pasture to have them pretty well filled up and no rain or dew on the clover to prevent bloat. Bloat seldom occurs after stock gets accustomed to clover pasture. In this respect clover is much less dangerous than alfalfa. As a soiling crop clover yields from 15 to 25 tons of green fodder per acre during the season, which may be fed to all animals.

Clover for Green Manuring. Clover is widely used as a green manure, the root and stubble being plowed under after the tops have been cut for hay. Sometimes the whole plant is plowed under, but this is not wise farm economy. It is better to cut and feed the hay, returning the manure to the soil, and turn under only the roots and stubble. According to the

Minnesota Station, an acre of clover yielding 2 tons of hay has 1760 pounds of roots. These contain about 39 pounds of nitrogen, 27 pounds of potash, 28 pounds of phosphoric acid, and 24 pounds of lime. In addition to the fertilizers in the roots, that contained in the stubble, crown and fallen leaves must also be added. The important facts regarding clover roots are that they add from 1500 to 2000 pounds of organic matter to every acre of soil, and from 30 to 50 pounds of nitrogen. They also change 20 to 30 pounds each of phosphates, potash and lime into more valuable forms of plant food for the use of succeeding crops. Where clover will succeed there is no crop grown that is better for green manuring.

Mammoth Red Clover is a larger, coarser plant than the common red clover which it otherwise closely resembles except that it ripens 2 or 3 weeks later. This habit makes it better suited for combining with timothy since they both mature more nearly together. The later maturity also enables it to escape the insect pests which attack the seed of the common red. Seed production is plentiful and the yield of forage is commonly larger than that of red clover. It blooms little during the first season and produces only one crop a year. It may live longer than two years which makes it useful in mixtures for pasture. Mammoth clover will do fairly well on poor soils where it is used as a member of a three-year rotation. The plant is somewhat more hairy than the red clover and more disposed to profuse branching in rosette form.

Crimson Clover (*Trifolium incarnatum*) also called scarlet clover, Italian clover etc., is the preferred winter annual legume in the northern half of Mississippi, Alabama and Georgia, and in Tennessee, South Carolina, North Carolina, Virginia, Maryland and Delaware. It is an erect, tufted annual, one to 2 feet high with hairy leaves and stems and bright scarlet or crimson flowers in elongated heads, providing a brilliant display of color. Used first as a source of hay it has come into more and more prominence as a cover crop wherever weather conditions are suitable. Mild winters and a reasonable rainfall are prime requisites. At its best in the middle and south Atlantic States, it has also been tested in Rhode Island, New York, Michigan, Illinois and elsewhere, and while occasionally successful as a summer crop it too often winterkills badly when fall-sown and cannot be depended upon outside of its preferred habitat.

Introduced into the United States over a hundred years ago it did not attain to great prominence until recent years. Being an annual its habit is wholly different from that of red clover. When planted in the fall the flowering stems develop rapidly in late spring ending in the conspicuous blossoms. Seed formation follows apace and the plant dies in the hot weather of summer.

Crimson clover is tolerant of either clay or sandy soils, is not particularly susceptible to acidity and will thrive on poor thin, soils better than red clover, being hence a more efficient soil renovator. Like most plants, however, it will of course give better returns on fertile, well-drained soils. On such land it often succeeds as a summer annual in Maine and Minnesota. Experiments in Alabama indicate that perhaps many of the failures with crimson clover, especially in the south, have been due to absence of tubercle-forming bacteria in the soil. When crimson clover seed was inoculated with these germs the yield averaged 2 tons of cured hay per acre as compared with only 760 pounds without inoculation. On poor, worn-out soils a moderate application of potash and phosphatic fertilizer may be used, but no nitrogen is needed. Lime exercises the same beneficial effect as with red clover. Wood ashes are particularly valuable.

The chief difficulty, as found by the Department of Agriculture, in the production of crimson clover, is in getting a stand. The soil must be moist enough to germinate the seeds promptly and give the young plants opportunity to become well rooted. When these conditions are met the crop is usually satisfactory. In the regular crimson clover belt seeding may be done in August or September either between the rows of cultivated crops or, better still, after the removal of a grain crop. Between rows the seed is broadcast and covered by harrowing. After plowing under grain stubble the soil must be thoroughly harrowed and packed before seeding in order to avoid the disappointment of failure.

Seed and Seeding. Crimson clover seed is larger than that of red or mammoth clover and is almost perfectly oval in shape. The seed has a bright reddish-yellow color and a high polish. This color changes to a reddish-brown as the seed becomes older. Eventually the seed loses its polish and takes on a dull, dark, red-

dish-brown color. Such seed should never be purchased, as it is too old to grow. American seed has proved more satisfactory here than European.

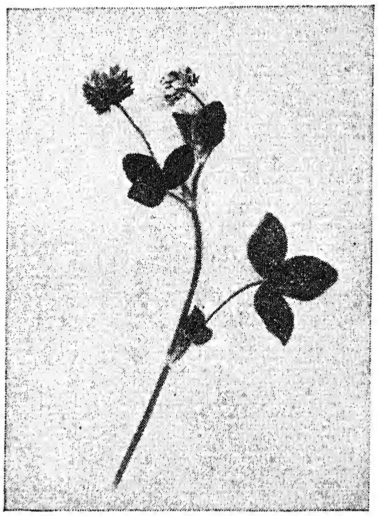
Crimson clover should be seeded at the rate of 15 to 18 pounds per acre. It may be sown either broadcast or with a drill. The former is the more usual practice, due largely to the fact that the clover is so often sown on land already occupied by some such crop as corn, potatoes or cotton. Here it is sown immediately after the last cultivation and without covering. It is not adapted for seeding with wheat or rye. When crimson clover occupies the ground alone it should be lightly harrowed or rolled in. If crimson clover is sown in the spring it makes a small growth, comes rapidly to maturity, ripens its seed the same season, then dies. If sown in summer or early fall it develops more slowly, lies semi-dormant through the winter, and completes its growth the following spring. It is the common practice in the Middle Atlantic and Southern States to sow the seed any time between July 15 and September 15. When seeded between these dates it matures the following spring from 3 to 4 weeks earlier than red clover.

Harvesting. This crop may be harvested in the same manner as common red clover. "It is sometimes difficult to cure properly, as it is ready to cut at a time when wet weather is likely to interfere. It may be cut for hay as soon as it comes into bloom and should never be cut for this purpose later than when it is in full bloom. The hairs upon the calyx of the flowers become hard and stiff as the plant matures and are likely to prove troublesome to animals eating the hay, forming 'hair balls' in the stomachs of the animals, which sometimes cause death. When harvested for the seed cutting should take place as soon as ripeness has been reached, to avoid loss through shattering. It is also well to thresh the crop or put it under cover as soon as it is dry, as heavy rains may injure the seed by causing it to sprout in the head.

"Under average conditions from 8 to 15 tons of green, or 1½ to 3 tons of cured forage may be obtained from an acre of crimson clover. Very poor soil or drouth may result in a lighter yield, while as high as 20 tons are reported under favorable conditions. The yield of seed per acre usually ranges from 8 to 12 or 15 bushels."

Uses. As a hay plant, properly cut and cured, crimson clover is superior even to red clover. It is similar in composition but richer in protein, its nutritive ratio being between 1:3.5 and 1:4. It is especially adapted for working and growing animals.

As a soiling crop crimson clover ranks high. It comes early in the season at a time when other forage plants are scarce and lasts about 20 days. At the New Jersey Station one acre of crimson clover yielded 2934 pounds of digestible food—a sufficient amount to maintain 10 cows in full flow of milk for 20 days. The green forage was found to contain 17 per cent more protein than red clover and 59 per cent more than green rye.



BRANCH OF ALSIKE CLOVER

Crimson makes one of the earliest and best pasture crops. When 6 inches high at the New Jersey Station it contained over 1300 pounds of digestible food per acre, an amount sufficient to properly nourish 12 cows 1 week.

As a silage crop crimson clover is the equal of red clover and is cut and put up in the same manner. The silage is considered especially valuable for feeding to dairy stock.

It is, however, as a green manure crop that crimson clover has one of its most important uses. Its season of growth is such that it can be used without in any way interfering with the production of the primary crop of grain or vegetables, and it affords a large amount of fertilizing material. The herbage is heavy, the roots are abundantly produced and penetrate deeply into the soil, and together these

form a large amount of vegetable mold, exerting a beneficial effect on the physical condition of the soil as well as adding much nitrogen and other valuable elements of plant food to the surface soil where it will be available to corn, wheat and other crops.

At the New Jersey Station a crop 6 inches high contained in the whole plant 104 pounds of nitrogen per acre; when 13 inches high it contained 168 pounds; in bloom 190 pounds; and when fully matured 212 pounds equivalent to the nitrogen contained in 20 tons of city manure. When a heavy crop of crimson clover is turned under it decays more rapidly and is less likely to "burn" the soil than a heavy crop of cowpeas turned under. The crop is often seeded advantageously with cowpeas, the cowpeas being used as a summer crop and followed by the clover for the winter. It is also seeded with red clover, Italian rye grass or vetch.

According to tests in New Jersey, crimson clover is peculiarly well adapted to use as a cover crop. It may be sown in corn, tobacco, potatoes, cowpeas, sorghum, and many other crops after the last cultivation, and when these are removed, will come on and occupy the land during the fall, winter and early spring, and may be pastured off or plowed under in time for the planting of the next crop. It is an excellent cover crop for use in orchards, where it is also one of the best of sources of nitrogen for the trees. Crimson clover in the orchard reduces the amount of cultivation necessary to keep the weeds in check, and if the crop is not needed for fertilizing the soil, it can be cut for hay, soiling or silage. The roots and stubble left on the ground from a crop of clover cut when in full bloom at the New Jersey Station contained nearly 40 pounds of nitrogen, over 10 pounds of phosphoric acid and over 14 pounds of potash per acre. When the crop is allowed to mature the potash in the roots and stubble is increased, but the nitrogen and phosphoric acid is reduced. This crop can be used in connection with small fruits as well as with peaches, pears and apples.

Alsike Clover (*trifolium hybridum*), a native of northern Europe where it has been cultivated for a millennium or more, was introduced into New York about 1850. The plant is intermediate in appearance between red and white clover, and was long supposed to be a hybrid between these species. It usually attains

ALSIKE CLOVER IN OREGON

a height of 1 to 2 feet but the stems sometimes reach a length of 3 to 5 feet. It is a perennial, thrives best in a cool climate and in heavy soils, even in soils too sour for red clover. Alsike will tolerate long continued overflows along river bottom banks, preferring silt or clay to sandy or gravelly soils.

The blooms are pink in color and are formed on branches along the whole length of the stem. From 5 to 6 pounds of seed is about the right amount per acre. Sowing is done in early spring, or sometimes in summer, in New Jersey where the crop follows potatoes or cabbage. Seeding on winter grain follows the same practice as with red clover. In Michigan it is occasionally sown with buckwheat in July. Alsike hay is superior to that of red clover though the acre yield is less. In feeding experiments with sheep in Montana alsike proved superior to alfalfa or red clover. It furnishes excellent pasturage. Five acres of alsike under irrigation in Montana provided pasture for 18 steers for 102 days during which the animals gained 4500 pounds of flesh, giving a value of $35. an acre for pasture.

The stems of alsike are weak and if grown alone it lodges and mats together. It is customary, therefore, to seed it with red clover or timothy as supports for the alsike. The hay is commonly greener than that of red clover, is more easily cured and is not so readily injured by rain. Leaves and flower heads are broken off and lost in large degree if the hay is allowed to become too dry before handling. Alsike appears to be quite immune to the diseases and insects which affect red clover. Like alfalfa and other clovers, alsike may cause bloating if animals eat too greedily of the green plant. Moreover, in Tennessee it is reported that alsike may produce sores on the lips or forelegs of horses and mules.

White Clover (*Trifolium repens*) is an important and familiar part of the flora of grazing lands in all parts of the U.S. except the great plains. In Illinois it proved particularly valuable by reason of increasing the palatability of the mixed forage in pastures. Lime and phosphate increased the growth of the mixture, but sodium nitrate and ammonium sulphate had a depressing effect. White clover is a low creeping perennial, not widely sown but naturally finds its way into meadows

FOUR ROW CORN CULTIVATOR

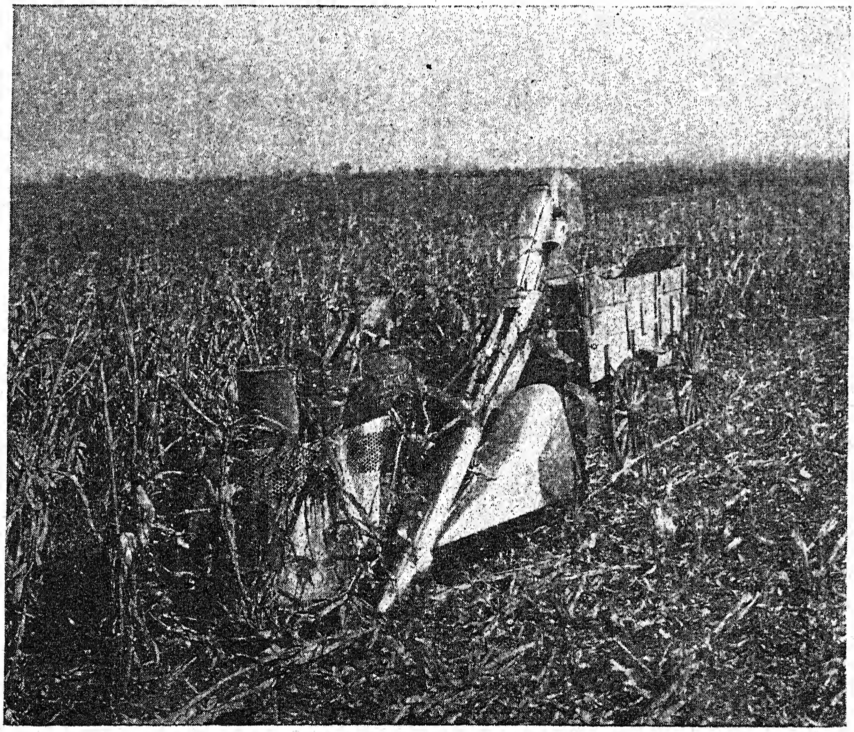
and pastures. It is used throughout the northern States in lawn mixtures, and is especially suited to seeding with blue grass. Its excellence as a bee plant is universally known. Where white and red clover plants grow in close association hybridization frequently occurs, the hybrid plants usually resembling alsike with delicately perfumed flowers. In Montana white clover has occasionally been harvested for hay, but it is usually too short for such use and is far more valuable for pasture.

Strawberry Clover (*trifolium fragiferum*), a native of Asia minor, has been casually carried in other seeds, or accidentally all over the world. As reported by the Department of Agriculture, the plant has appeared sporadically in various parts of the U.S. since 1900, sometimes found in seedings of grasses from Australia where its use is extensive. The plant is a perennial and spreads by roots from the nodes of the creeping stems. It is hardly distinguishable from white clover except by the flower heads which are round or pointed, pinkish in color and resemble strawberries. This plant seems especially adapted to the Western States where it thrives on alkali soils and tolerates a range of temperature from summer heat to 40 degrees below zero. Strawberry clover is so palatable that live stock tend to graze it closely in preference to other plants in the mixture. In some localities the crop is grazed till June, after which sufficient growth to produce a fair yield of seed is obtained.

Ladino Clover, a variety of white clover, has been tested in Colorado and elsewhere. It makes satisfactory pasture where moisture is plentiful and alkali not excessive. Its preferred habitat seems to be along creek bottoms, in shady places or in overirrigated areas. Ladino clover cannot survive competition with weeds or other farm crops. Hence the seed bed must be well prepared and firm. The seed should be covered only lightly and the soil kept moist for several weeks after sowing.

CORN

No American family gets through a single day without eating corn in some form. Ham, steaks, lamb chops, turkey



MODERN CORN HUSKER

drumsticks, eggs, milk, butter and cheese are only transmuted and glorified corn. Biscuits are probably shortened with a lard compound containing corn oil. Flapjacks may be a mixture of corn meal and flour, and the syrup poured on them an extract of corn. Then there are hominy, corn pone, hasty pudding, tamales, tortillas, succotash and scores of other corn-made dishes. And corn has become one of the great chemical laboratories from which come furfural for making dyes and resins, starch, oil, sugar, gums, gluten, dextrose, grits, glycerin, soap stocks and whatnot. Nearly ¼ of our corn crop is used in making special products. No wonder that at the close of the first corn harvest in Massachusetts in 1621 Governor Bradford set aside a day of thanksgiving.

CULTIVATING CORN IN KANSAS

Since 1900 the U.S. corn crop has ranged between 87 and 110 million acres while the yearly production has been from 1½ to 3 billion bushels. The chief corn States are Iowa, Illinois, Indiana, Ohio, Minnesota, Nebraska, Missouri in the central part of the corn belt, Pennsylvania and New York in the east, and Texas, Kentucky and Tennessee in the South.

Soil. The rich friable loams of the Mississippi States are the ideal corn lands of the country, and these States furnish the bulk of the corn crop. Good crops, however, can be obtained on a variety of soils varying from the lighter sandy loams to heavy clays. When a choice can be had a warm, porous, well-drained loam should be chosen. Corn is a rank grower and succeeds better under unfavorable soil conditions than most farm crops. This is due to the remarkably strong root system of the plant. Within 60 days from planting, corn roots have been traced 8 feet deep and as far laterally. The main bulk of roots, however, has been found to develop within 8 inches of the surface of the ground. Within this area a dense network of feeding rootlets reaching from row to row and completely permeating the whole soil area below the cultivated portion is formed.

Plowing and Cultivating. Thin soil should be plowed shallow. On good soils depth of plowing seems to have but little influence on the crop. Plowing 5 to 7 inches deep is usual and is recommended. Subsoiling for corn is not a profitable practice. Corn should be cultivated about once every week or 10 days, and especially after every rain, in order to break up the crust and preserve a dust mulch. Begin soon after the seed is sown and continue the cultivation until the stalks are nearly as high as a man's head. A light spike-tooth harrow can be run over the field until the plants are 6 inches high, after which a cultivator, which will run

between or straddle the rows, should be used. The essential thing in corn cultivation is to keep the ground free from weeds. The results of 56 tests at 17 different Agricultural Experiment Stations show an average increase of 42 per cent resulting from shallow cultivation as compared with deep cultivation. In moist years cultivation is of less importance than in dry years. At the Wisconsin Station cultivation 3 inches deep left the ground more moist below the cultivated layer than cultivation 1½ inches deep. If we base methods of corn cultivation on the root development of corn it would seem that level cultivation 2 to 3 inches deep is most logical, and this depth is favored by most all the experiment stations. The kind of implement used in the cultivation of corn is not of so much importance as thoroughness and carefulness in using it.

As pointed out by M. T. Jenkins "the greatest plant breeding job in the world was done by the American Indians. Out of a wild plant not even known today, they developed types of corn adapted to such a wide range of climates that this plant is now more extensively distributed over the earth than any other cereal crop." In Peru the Inca Indians developed a short-eared variety with black flinty kernels for lowland use and the tall, wide-kerneled, soft, starchy strain for growing in the high Andes. Portuguese navigators introduced corn into Africa in 1550 and today it is grown in every corner of that continent frequently disguised under the name mealies. Argentina and Brazil head the list of corn producing nations in South America. The Danube Basin, Italy and Spain rely greatly on corn for food. Australia, Java and Egypt are among the devotees of corn.

Corn needs high temperatures night and day for best results during the growing season. It does not thrive where the average night temperature falls below 55 degrees F. during the 3 summer months. Flint varieties stand more adverse weather conditions than do the dents. Corn is raised on the arid plains of Russia under a 10 inch rain fall, as well as in Hindustan with 200 inches of rain. But precipitation in the U.S. corn belt is 25 to 30 inches, of which 7 inches fall in July and August.

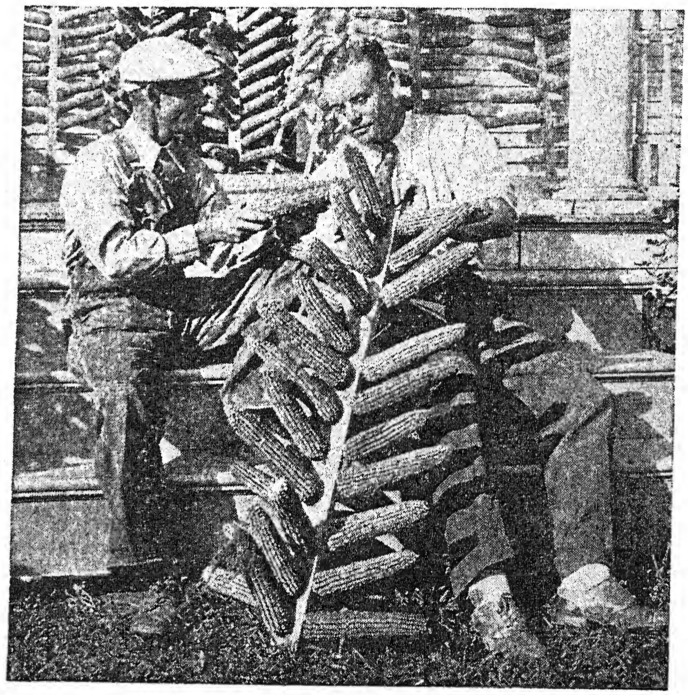
Planting. The time for planting corn will, of course, vary with the locality and with weather conditions. From southern Michigan west to Iowa and south to Kansas plantings between the 1st and 15th of May have generally given the best results. The rule should be to plant just as soon as danger from frost is past, and the earlier thereafter the better. From 2 to 3 inches is considered the best depth for planting corn.

Experiments made thus far indicate that where corn is grown for grain closer planting is more usual in the Northern than in the Southern States. At the stations in Alabama, Georgia, Louisiana and South Carolina, rows from 4 to 5 feet apart, with stalks at intervals of 3 to 4 feet, are preferred. With the closer planting occur larger total yields, larger yields of grain, smaller ears, and more nubbins. If the corn is grown for grain the husking of the increased number of smaller ears increases the cost of the harvest; but if the corn is grown for silage and the grain ensiled with the stalks, the smaller ears are no disadvantage. Rows about 40 inches distant, with single stalks 3 to 9 inches apart in the row, are considered the best distance for silage corn at the Pennsylvania and Michigan Stations. There is practically no difference in the results whether corn is planted in hills or drills, convenience in planting and cultivating being the chief factors for consideration. The total number of stalks per acre influences the yields rather than their method of distribution. When planted in hills at the Illinois Station, 4 kernels in hills 3 feet 8 inches apart each way gave the largest yields of grain.

The length of the growing period of corn varies much. On the northern borders of the corn belt some small flint varieties develop in 70 days, and dent corn if grown at all mature only sufficiently for silage. In the Southern States where dent corns are grown almost exclusively, the growing period averages 150 days. In the latitude of Illinois 100 days may be considered the minimum for field corn to fully mature, while later varieties often require 150 days.

Seed. The general belief that seed corn obtained from other soils or more northern localities is better than home-grown seed has not been substantiated by experiments in Alabama, Arkansas, Indiana, Maryland, or Oklahoma. On the other hand, the experiments at these stations clearly show the desirability of using only corn for seed which has been grown in the same latitude and preferably in the same neighborhood where it is to be planted. At the Michigan Station fully matured seed increased the yield 11 per cent as compared with seed not fully ma-

tured. In a recent report from the Wisconsin Station it is shown in experiments extending over a period of 5 years with a variety of flint corn, very immature seed gave smaller yields of corn and stalks and slightly earlier maturity than fully matured seed. The largest yield of corn and stalks, however, was from corn gathered slightly immature. On the whole it would seem best for every farmer to use mature seed corn grown on his own farm, or at least in his own neighborhood. This should be selected in the field, the best ears from the most productive stalks being taken. Seed corn should be stored in a dry place over winter away from the mice.



SELECTING SEED CORN

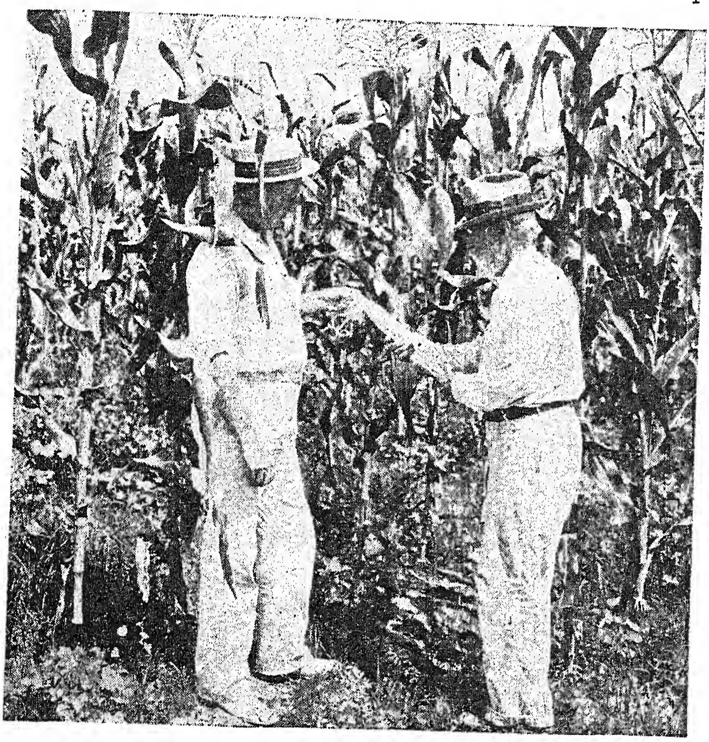
Stripping, Topping and Detasseling. Sometimes the leaves are stripped off the stalks while the crop is growing and used for fodder. This practice reduces the yield of corn, and it is doubtful whether the fodder thus obtained will pay for the trouble of gathering it. Cutting off the tops above the ears when in good condition for fodder has in some cases decreased the yields, and in others it has not. In 20 detasseling experiments at 10 different stations the crop was increased in 7 instances, decreased in 8 and in 5 no effect was noted. In general it may be stated that the increased yields obtained by detasseling are so slight that the practice is of doubtful benefit.

Fertilizing. Experiments in manuring corn have been carried out at nearly all the experiment stations and with a vast number of different fertilizers and combinations. The results secured are as variable as the soils upon which the corn was planted and the manures used. In a general way it may be stated that barnyard manure is one of the most effective fertilizers for corn. In some of the Western States all forms of fertilizers have been used without benefit, but in the Eastern States better results are obtained by the use of some fertilizer. Complete fertilizers containing phosphoric acid, combined with nitrogen and small amounts of potash, are most likely to give good results. Corn is a rank growing plant and its extensive root system and comparatively long growing period permits the use of coarse manures. Corn does especially well when grown after such crops as clover, peas, alfalfa, crim-

son clover, melilotus and other similar leguminous crops.

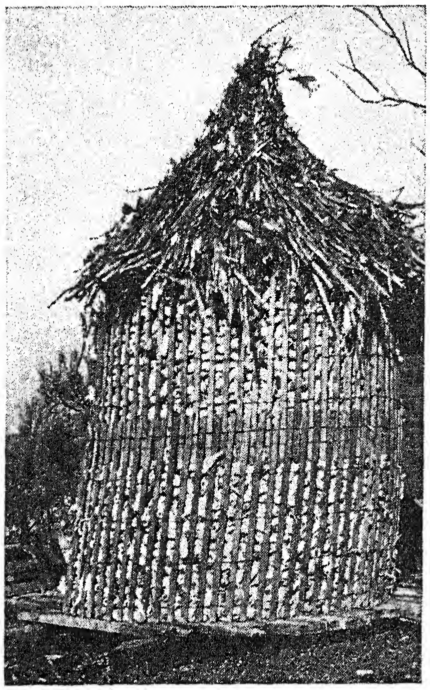
On the farm the corn field is a good place to put the coarse stable manures that have to be hauled out before they become rotted. The manure should be plowed under. The long growing season of the corn will enable it to utilize the manures as they slowly decompose, and the large amount of weed seeds which the manure contains will germinate and be destroyed by the thorough cultivation of the corn, thus furnishing a clean seed bed for a grain or grass crop which may follow. Cotton seed for heavy lands and cotton seed meal for light lands is quite generally recommended throughout the South.

The labor cost of harvesting corn is greater than in the case of other cereals. The weight of the crop is greater and a larger part of the work is done by hand. The Department of Agriculture has recently estimated that in harvesting the ordinary corn crop of 2 billion bushels or 70 millions tons of ear corn, if all the work were done by hand, about 250 million man hours would be required. Nevertheless it is probable that 90 per cent of the corn crop is still harvested by hand. Where the corn acreage per farm is small the old familiar method consists in cutting and shocking the corn before frost and husking later, often not till late fall. Or the corn is allowed to stand till the ears are thoroughly cured when they are husked from the standing stalks as on most of the larger farms of the corn belt. Since 1904 experiments have been in progress with mechanical corn pickers and huskers. The Iowa Station has been testing machine harvesters for several years. It appears that with continuous operation at a speed of 3 miles per hour a 2-row machine would harvest 2½ acres per hour. The Iowa Station has found that the "characteristics desirable for machine picking are: stiff stalks to reduce storm damage, tough ear shanks to reduce the number of ears that drop off before harvest, large ears and hard shelling to reduce loss of shelled corn at the snapping rollers." The 2 essential features of these machines are the snapping rollers to break the ears from the stalks and the husking rollers.



INSPECTING CORN

Where hand methods of harvesting are in vogue, the consensus of opinion is that corn for both grain and stover should be harvested soon after the kernels are well dented and the blades begin to dry, but before the ears are thoroughly ripened. For silage, harvest flint varieties when just past glazing, and dent varieties when well dented.



EMERGENCY CORN CRIB

In recent years much attention has been attracted to hybrid varieties of corn as compared to the open-pollinated strains. In Kansas tests during the past several years have shown that the hybrids stand up well and produce at least 15 per cent more corn than the open pollinated varieties. In Illinois hybrids have also proved superior for silage in both quantity and quality. In case of doubt as to the variety to be selected the State Experiment Station should be consulted.

Rotation. Corn enters into nearly all American farm rotations. For general farming outside the cotton belt a good 4-year rotation is as follows: First year, corn; second year, oats; third year, wheat seeded with grasses in the fall and clover in the spring; fourth year, clover and grass. The coarse barnyard manures should be applied to the corn crop, which is best able to use them. In the Southern States corn, cowpeas, cotton and small grains enter into the rotation in a number of different combinations. The Alabama Station recommends a 3-year rotation as follows: "First year, corn with cowpeas between the rows, if the land produces less than 20 bushels of corn per acre, followed by winter oats; second year, winter oats, followed by cowpeas; third year, cotton."

Feeding Value of Grain. Corn grain is relished by all farm animals. On account of its high starch and oil content it is pre-eminently adapted for fattening purposes and stands at the head of the list of grains for this purpose. In fattening cattle or hogs or for feeding to milch cows producing a heavy flow of milk the grain is somewhat more effective if ground, since in this form it is most easily and completely digested. It is not necessary to grind the grain for sheep worth feeding, and to horses it should be fed whole. Corn is not quite as good as grain feed for horses as oats on account of its tendency to produce fat. Foreign experiments go to show that it may, however, constitute one-third of the grain ration where oats makes up the other two-thirds, and at a less cost and with as good results as where the whole grain ration is made up of oats.

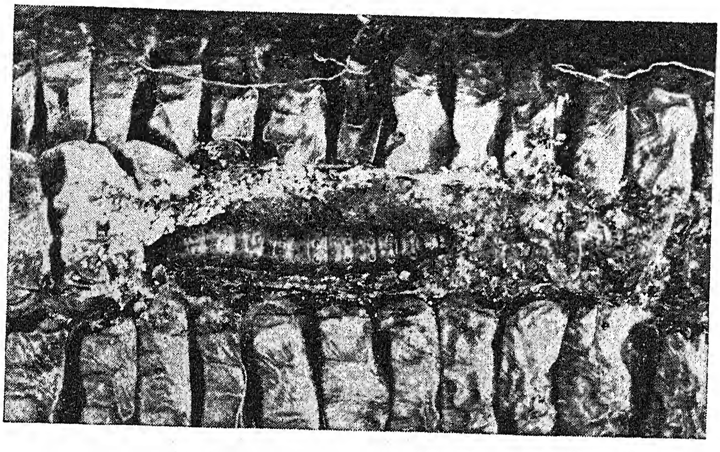
In the corn growing districts of the West it is the common practice of feeders to give fattening steers unhusked corn. The stalks with the ears are thrown in racks, from which the steers pick out the grain and such portion of the fodder as is palatable. Shoats are allowed to run with the steers and pick up whatever shelled and undigested kernels there may be. While this seems like a wasteful practice it possesses the advantage of cheapness, and the unhusked grain is preserved in a fresh and especially palatable condition. Where corn is cheap, as in the central corn belt, this is the most economical method of feeding it to steers. Cattle may just as well husk their own corn as to pay a round price for having it done by hand labor or machinery. It requires on an average a little more than 1000 pounds of grain to give 100 pounds of gain in flesh with steers. Where the ears of corn are large or especially hard and dry some mechanical treatment is very desirable. As noted before, the ground grain is especially valuable; but it is a concentrated food and must be fed with care or the animals are liable to get off

feed. Especially is this true in the later stages of fattening, when the animals have a delicate appetite. Bran, ground cob, etc., should be fed with it. If grinding is not resorted to, soaking the corn in water until it begins to soften may be practiced with good results. The Kansas Station found that steers fed soaked corn gave larger gains on less grain than where fed dry corn. On the whole, there was a saving of 15 per cent by soaking the shelled corn. Large ears of corn should be broken up in the feed box with a hatchet. Or if the whole cobs, grain and all, with or without the husks, can be run through a crusher, so much the better. For milch cows corn should not form over one-half the grain ration; since for milk production, as for lean meat, grains richer in proteins are required.

Corn is the most commonly used grain for hogs, but with young pigs, as with all other growing animals, it should not constitute the whole of the concentrated ration for a long period. Better quality and firmer meat and a larger proportion of lean may be obtained when it is fed with some more highly nitrogenous grain, as peas or barley. Unless too dry it may be fed whole. Very dry corn should be soaked. Corn meal should always be soaked when fed to hogs to increase its palatableness. The experiments in feeding hogs corn and cob meal vs. corn meal are somewhat conflicting, but practical experience is in favor of feeding the ground cob with the grain.

For sheep no grain excels corn, especially for fattening lambs. Numerous experiments go to show that it requires about 500 pounds of grain to produce 100 pounds of gain. Soaking corn for sheep is an undesirable practice. For a further account of the feeding value of corn see under each of the different farm animals and poultry.

Fodder Corn. Corn fodder, or fodder corn, as the term is generally applied, has reference to the whole corn plant, either dry or green, when grown for fodder, and includes the stalk, leaves and ears. Corn stover is the stalks and leaves without the grain. More than one-third of the feeding value of the corn plant is in the stover. Therefore much will be lost if this is not utilized. It is a common practice where corn is grown for grain to harvest the corn in shocks or stooks and husk out the grain by hand. When the grain is fed to steers or dairy cows this husking is a useless and expensive practice. The cattle rather do it themselves. Corn fodder which has been grown so thickly that the ears are scarcely half size is one of the very best fodders for horses, young cattle, dairy cows and steers in the first stages of fattening. Corn stover is, of course, less valuable, but for horses not at work and for the maintenance of cattle and sheep over winter it possesses much greater value than is usually ascribed to it. Especially is this true when the stalks are run through a shredder or feed cutter and the coarse stalks made more easy of mastication.



CORN BORER IN EAR OF SWEET CORN

So wide-spread and important a crop as corn could not have easily escaped its quota of diseases and insect enemies. More than 350 species of insects attack corn, 160 of them being rather injurious,

particularly corn ear worm, European corn borer, grasshoppers, cut worms, etc. The European corn borer appeared near Boston in 1917 and has since spread to Maryland, Virginia, Ohio, Indiana, Michigan, Kentucky and West Virginia. Its spread and the virulence of its attacks seem to be abating and better control methods have been found. The larvae pass the winter in their burrows in the stalks and the moths emerge in late May and early June in Connecticut. The young larvae feed between the leaves and in the ear shoot. Four dustings or sprayings have been helpful at that season. Nicotine dust or sprays prepared from derris roots have given satisfaction. The usual control method consists in feeding, burning or plowing-under before May 15 all parts of the corn plant left on the field from the previous year. Cut worms and grasshoppers may be destroyed by poisoned bran.

Pop Corn is adapted to the same soil and climatic conditions as field corn and requires the same care. The kernel possesses a tougher coat than common field corn and when heated sustains the increasing inside pressure till it reaches a point sufficient to rupture the kernel which is said to "pop" or turn inside out. Pop corn was known to the Indians before the white man came to America. It is raised in small patches for home use in every State, but only a few States grow it on a commercial scale. Iowa and Nebraska are the leading States, Iowa with an average of 25,000 acres and Nebraska with 8,500 acres, and yields of 1600 and 1100 pounds per acre respectively.

CORN DAMAGED BY EUROPEAN BORER

There are 2 main types of pop corn,—the rice corn with pointed kernels, and the pearl corn with rounded kernels. According to the Department of Agriculture White Rice pop corn is the most popular and is largely used for confections and for concession stands at places of amusement. The ears have 16 to 20 rows of kernels and are about 7 inches long. Hand harvesting is very tedious and in recent years mechanical pickers have been widely in use. Market demand for pop corn is fairly constant but the supply is pretty closely adjusted to the demand.

Sweet Corn as a commercial industry has been most highly developed in Iowa,

Illinois, Maryland, Ohio, New York, Indiana and Maine, the total U.S. production running from 395,000 to 625,000 tons on an area of 200,000 to 314,000 acres as reported by J. H. Beattie. It is rather tender, and successful production requires a growing period of 85 to 120 frost-free days. Warm, but not excessively hot weather is best. In the South it does not retain its sweetness. Harvesting occurs when the kernels are plump and full of milk or just as the silks begin to turn brown. The ears are snapped in the husk leaving a short shank at the base. During the process of ripening the sugar changes to starch. "If harvested too late the product will be lacking in flavor, will be starchy and will have tough seed coats."

The reported yields have ranged from 1 to 8 tons per acre, with an average of about 2 tons. In the early days of the canning industry only white corn was used, but the yellow kinds are increasingly forging ahead. On some markets for immediate table use only yellow corn is called for by the consumer. The most popular varieties of sweet corn have long been familiar to roasting ear epicures, namely Golden Bantam, Stowell Evergreen and Country Gentleman.

Sweet corn may be fitted into a number of rotations. If clover and timothy sod is allowed to stand 2 years and is then followed by sweet corn, soy beans or rye may be sown at the last cultivation of the sweet corn.

The factory wastes from canning include husks, silks and cobs which amount to 55 to 70 per cent of the weight of the unhusked ears delivered to the cannery. These wastes may make a valuable silage. Moreover the stalks and immature ears left in the field at the last picking are valuable for fodder or silage.

HARVESTING SWEET CORN

COTTON (*Gossypium* spp.)

Just 150 years ago Eli Whitney invented the cotton gin, a mechanical device for separating cotton fiber from the seed. For 30 or perhaps 40 centuries the orientals, with their limitless patience, had laboriously hand picked the lint, or had removed the seed by a small contraption with 2 wooden rollers, engaging each other by a spiral wooden gear. The cotton was fed in with one hand while the other hand turned the crank. After all these centuries this implement may be seen in operation on small peasant holdings in China slowly providing the lint for padding the native blue cotton garments. The effect of Whitney's invention was little less than marvelous. It wrought a new civilization, an economic empire based on cotton. The South became the Cotton Belt, the home of cotton.

Cotton is a fiber which thrives under a wider range of climate, is grown by a greater number and variety of people, and is used for a larger number of purposes

than any other fiber. Cotton is by nature a perennial. Its original home is in the tropics where it may attain a height of 10 to 15 feet, producing crops of lint from year to year. But the growing season is long enough to produce one crop of cotton between frosts in vast areas outside of the tropical zone. In practice, therefore, it is treated as an annual and is replanted yearly. Thus it comes about that cotton is successfully raised in the Western Hemisphere from the equator to 37 degrees north latitude and to 32 degrees south latitude, and in the Eastern Hemisphere into the Ukraine at 46 degrees north and into Africa and Australia to 30 degrees south. The growing season required for the annual crop varies from 5 to 6 months. Treated as a perennial, it is difficult to force the plant into definite seasons of maturing. In Peru and Hawaii trials have been made in cutting back the plants to a height of about 1 foot at the close of the first season, and allowing them to produce 1 or 2 ratoon crops instead of seeding annually. The results were not particularly favorable.

Cotton belongs to the mallow family along with hollyhocks. Two species have long been grown in the South, Upland and Sea Island. The latter is of peculiar importance on account of its longer, silky fibers which fitted it for many special uses. With the advent of the boll weevil the planting of sea island cotton was practically abandoned on account of its unusual susceptibility to damage by that insect. In recent years, however, sea island seems to be coming back, especially on the coastal plain of Georgia, Alabama, Mississippi, Louisiana and Texas, since better methods of control have been learned. Cotton in the South is a branching annual shrub usually 3 to 4 feet high. The flowers of the Upland variety are white or cream colored the first day, becoming pinkish on the second, and falling on the third day, leaving a small boll in the calyx. The boll grows to the size and shape of a hen's egg when it splits into 3 to 5 cells exposing the numerous black seeds covered with the cotton fibers.

LONG STAPLE COTTON

The importance of cotton to the southern States is seen in the extent of cultivation of the crop which, since 1900 has ranged from 27 to 46 million acres and a production of 9 to 18 million bales of 500 pounds each. During the same period our exports of cotton to all countries varied from 5 to 9 million bales, the total world production in 1939 being around 27 million bales. For many years we produced 60 to 65 per cent of the world's cotton, and spinners from far and wide

looked to U.S. for their supplies. Our large scale methods of farming made it possible to dominate the market. The U.S. crop of 1931, for example, was nearly 17 million bales, whereas, outside of India, where cotton has been grown for 4000 years, the whole British Empire had worked up only to 300,000 bales. But variations in prices and quality of lint along with other considerations, led foreign manufacturers to look to other cotton growing countries for their raw cotton and to take part in financing cotton production wherever suitable areas were available. For several years the cotton output of our competitors has been growing, at least up to the outbreak of the Axis powers into universal piracy, so that we now have to share cotton honors with Brazil, Russia, India, China, Egypt and many other less extensive developments.

Notwithstanding the numerous modern improvements in methods of planting, cultivating and harvesting, the crop requires a great deal of hand work. The Texas Station insists that we must look to more perfect harvesting machinery for further reduction in labor. This Station has developed a stripper-harvester, with a bur extractor, which picks 4 or 5 acres per day and gathers 95 to 98 per cent of the seed cotton. By contrast 100 pounds is a fair day's work by hand labor. The seriousness of the labor problem is apparent when it is remembered that the picking season lasts about 100 days, and that the fields must be gone over 2 to 4 times as the bolls ripen. The perfect mechanical cotton picker has not appeared but it may be in the offing. There is some difficulty in adjusting such machines to the varying height of the cotton. Bits of broken leaves and other trash are also gathered by the mechanical pickers which puts an added burden on the ginner to turn out clean fiber.

CULTIVATING COTTON

In estimating requirements of raw materials for war needs it was soon found that cotton was perhaps as essential as rubber. This is due to the almost endless uses of cotton for clothing, airplanes, autos, bags and the thousand and one industrial uses as well as for household purposes, foods, soaps, cellulose, stock feed, plastics, etc. A page of fine print would no more than barely hold a mere list of such items. But the cotton experts of the Texas Station go on to elaborate their

point. We may have an ample supply of cotton but quantity is not sufficient. The demand for high grade and medium lint is increasing. While we may have enough cotton shorter than 7/8 inch for a three years' supply, and a two years' stock for 7/8 to 29/32 inch, we have less than a years' supply of staples 15/16 inch or more in length. Strength, uniformity and spinnability are what the manufacturers are demanding. One of the answers to the

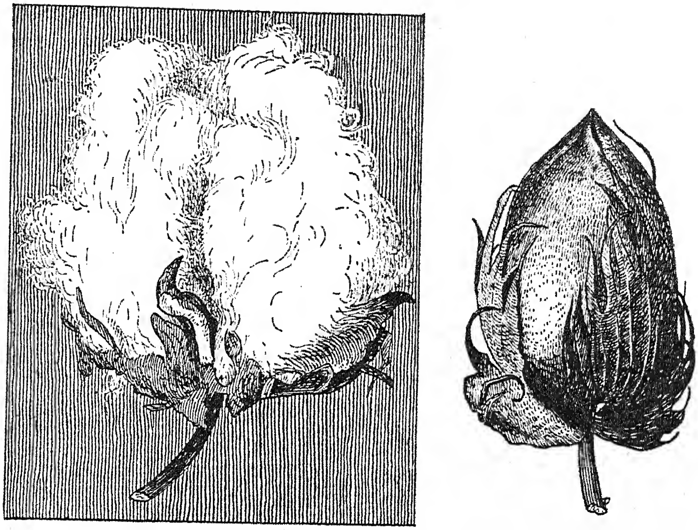
PICKING COTTON

problem of uniformity is found in the wider spread of so-called community production, whereby neighbors, by cooperative action, agree on one variety of cotton to be planted by all members to the exclusion of other varieties, and to plant only selected seed of that variety. The long continued planting of run-of-the-gin seed had resulted in the production of a motley collection of grades and staples in almost every community, thus making it difficult for the ginners to segregate the qualities.

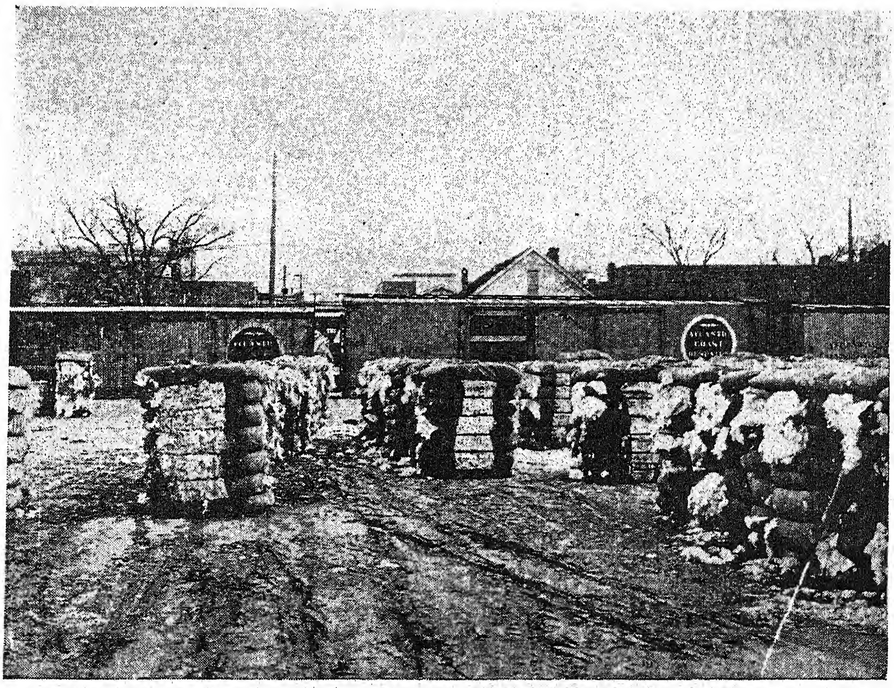
The most favorable climatic conditions for cotton production in U.S. are a mild spring with light and frequent rainfall, a moderately humid summer with warm days and nights, and a long, dry and cool fall. The cotton plant has a deep tap root which enables it to withstand drouth fairly well. Clay loams and sandy loams resting upon clay are recommended. Humus is required. Deep and thorough preparation of the seed bed is urged by growers and experts in all parts of the cotton belt. The roots are shallow and may be badly injured by deep cultivation during the growth of the crop. Shallow and frequent cultivation is necessary to keep down the weeds. All subsequent operations are lightened and the yield is improved by deep plowing and thorough harrowing of the ground before planting. Grass is the bane of the cotton grower and must be held in control.

The rate, spacing and depth of planting vary so widely in different localities that on these points it is best to depend upon the suggestions of successful farmers in each region.

The Bureau of Chemistry has estimated that in the production of 40 to 50 million acres of cotton about 2 million tons of fertilizers are used yearly, about 70 per cent of the amount being applied in North Carolina, South Carolina, Georgia and Alabama. About 95 per cent of the cotton land of the south-eastern States is fertilized, while much less is utilized farther west. Average applications west of the Mississippi are about 500 pounds and 600 to 800 east of the river. All experience indicates that cotton seed should



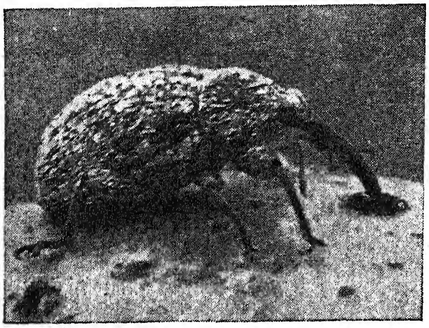
MATURE OPENED AND UNOPENED COTTON BOLLS



COTTON BALES AT SHIPPING STATION

not be planted in contact with the fertilizer but that the fertilizer should be placed 2 or 3 inches below the seed or, on some lands still better, about the same distance to the side of the seed row.

Cotton fiber is easily soiled or injured by rain or carelessness in picking. Top prices are paid only for clean fiber. The cost of picking may be 20 per cent of the total outlay, but it is foolish to spend the other 80 per cent and then spoil the crop by neglect. Ginners and growers are often equally negligent in this regard.



BOLL WEEVIL ENLARGED

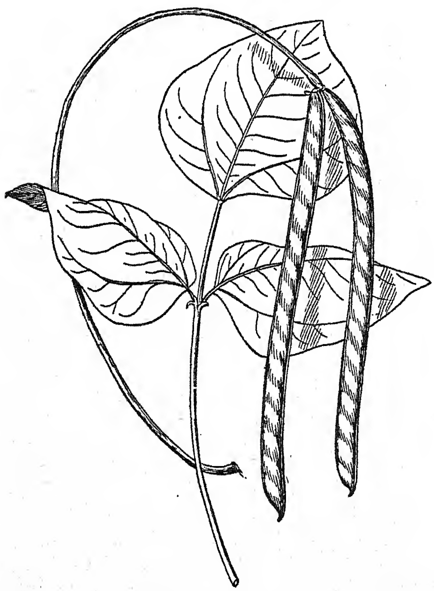
Cotton has not escaped the attention of more or less serious insect enemies and diseases. No one could have failed to hear of the ruinous march of the boll weevil from Mexico across the U.S. cotton belt. This is a chocolate colored or black snout beetle about ¼ inch long. The adult insect comes out of winter quarters where it has been hiding under trash of any kind, and attacks young squares or bolls. The period of emergence from hibernation ranges from early March to July. The weevil punctures the squares for feeding or egg laying and the infested squares soon drop. The entire length of a generation from egg to adult is 2 or 3 weeks and there may be several generations in a single season. Fortunately an effective remedy is at hand. The Bureau of Entomology recommends dusting the plants with calcium arsenate, as soon as 10 per cent of the squares has been attacked, at the rate of from 4 to 6 pounds per acre. Large scale ground machines and airplanes have been used in spreading the insecticide. The earlier the crop is started the better the result since thereby a higher percentage of the crop is beyond the square stage before the weevils wake up from their winter sleep. For control of the many other insect enemies of cotton, the grower may best call on the County agent or State Experiment Station for advice.

Root rot is the most destructive disease of cotton, occurring in Texas, Oklahoma, Arkansas, New Mexico and Arizona. No good remedy has been discovered, but a 2 or 3 year rotation, combined with deep plowing, helps measurably. Fusarium wilt, another serious disease of cotton, can only be avoided in infected areas by planting seed of resistant varieties of cotton.

COWPEAS (*Vigna sinensis*)

The cowpea, widely distributed in Africa, Asia and the Mediterranean region, and introduced into North Carolina in 1714 or earlier, is now raised more extensively than any other legume in the South, the total acreage of this crop for the U.S. being 5,385,000 acres with only a few thousand acres north of Maryland.

According to the classification of W. J. Morse of the Department of Agriculture, there are 3 groups of cowpeas:—the cowpea proper, the catjang and the asparagus



COWPEA

bean. Of the first group the Whippoorwill, Iron and New Era and their hybrids are most valuable. The best known is Whippoorwill, a tall, bushy prolific variety, maturing in about 75 days, seeds buff speckled with blue. The catjang group, or Hindu cowpeas, are half-bushy

with small oblong seeds and erect pods 3 to 5 inches long. The blackeye varieties belong here and have been grown as a table vegetable since ancient times. The third group includes the Asparagus, or Yard-Long bean with procumbent viny plants 1 to 3 feet long, inflated soft beans used in China and parts of Europe as snap beans for human food.

The advantages of growing cowpeas are briefly summarized by the Louisiana Experiment Station as follows: (1) The cowpea is a nitrogen gatherer; (2) it shades the soil in summer, keeping it in a condition most suitable to the rapid nitrification and leaves it friable and loose and in the best condition for a future crop; (3) it has a large root development, and hence pumps up from great depths and large areas the water, and with it the mineral matter needed by the plant; (4) its adaptability to all kinds of soils, stiffest clays to most porous sands, fertile alluvial bottoms to barren uplands; (5) it stands the heat and sunshine of Southern summers; (6) its rapid growth enables the farmer in the South to grow 2 crops a year on the same soil; (7) when sown thickly it shades the soil effectively, smothering out all weeds, and thus serves as a cleansing crop; (8) it is the best preparatory crop known to the Southern farmer, every kind of crop grows well after it; (9) it furnishes a most excellent food in large quantities for both man and animals.

COWPEAS FOR HAY

Seeding and Cultivation. The time and manner of growing cowpeas is conditioned upon several factors. If vines are wanted in the South the crop should be planted early; if seed is wanted, later planting will give better results. The amount of seed to sow depends in a large measure on the size of the peas and whether they are sown broadcast or drilled in. Seeded broadcast from 1 bushel of the smaller to 2 bushels of the larger seeded varieties will be required; while if drilled in the amount will vary from 6 to 16 quarts. If the crop is planted early or on comparatively rich land a less amount of seed will be needed than for late plantings or on poor land. Experiments at the Georgia Station show that discolored peas are just as good for seed as any other.

The cowpea requires a warm, moist seedbed, and the peas rapidly rot if the seed is planted too early, while the ground

is still cold and wet. This fact accounts for many failures reported from Northern States where attempts have been made to grow the cowpea. The ground for the crop should be plowed and harrowed until a good tilth is secured. When sown in drills the rows are made from 18 to 30 inches apart depending on whether the smaller or larger varieties are grown. The seed should be covered about 2 inches deep. When the seed is drilled in the rows can be cultivated one way. As to the relative merits of drilling and broadcasting cowpeas, the Mississippi Station states that it has been its experience that the increase in yield in both seed and hay obtained when the cowpea was drilled in was more than sufficient to pay for the additional expense in drilling and cultivating the crop.

When the crop is sown broadcast and harrowed in it requires no further attention in the way of cultivation. It requires, however, a greater amount of seed, the growth of the plant is less vigorous, and the crop is not so easily cut if wanted for hay as when the seed is drilled in. When seed is plenty and labor scarce the general custom is to sow broadcast.

Fertilizing. It has been clearly shown by experiments at a number of stations that fertilizing the cowpea with nitrogenous fertilizers is not necessary nor profitable. This plant is able to secure all the nitrogen it requires for its growth from the air. (*See Leguminous Plants.*) It responds promptly to small applications of phosphoric acid and potash on most soils, but large applications have not been found to pay. The Georgia Station states that in the oak and hickory belt of that and adjoining States it is doubtful economy to supply even small amounts of potash. At the Delaware Station the use of 160 pounds of muriate of potash doubled the yield of vines, while superphosphate was without effect. In Georgia the best yields were obtained when superphosphate at the rate of 200 to 400 pounds per acre were used. Generally 100 to 150 pounds per acre will be found sufficient. Stated briefly, rules for fertilizing cowpeas may be formulated as follows: On soils devoid of vegetable matter use stable manure, cotton seed or other organic manures. On very light soil cotton-seed meal is preferable to cotton seed and should be used at the rate of 150 to 200 pounds per acre as a top dressing. On soils long under cultivation use 100 to 150 pounds of acid phosphate and about the same amount of muriate of potash, or the equivalent of these in some other form. Potash is not likely to be of much benefit on clay soils.

Harvesting. At the Georgia Station it was found that the best disposition of a crop of cowpeas was first to convert the vines into hay, or silage; and second to permit the peas to ripen and gather or pasture them "Mowing the vines and allowing them to lie on the surface and plowing under in November was decidedly better than turning the vines under in August." Turning the vines under green gave the poorest economic results of all.

Owing to the rank and succulent nature of cowpeas they are somewhat difficult to cure into hay. The vines are cut for this purpose when the first pods begin to ripen. The method of curing which has given good results in Mississippi is outlined by the experiment station as follows:—"The mower is started in the morning as soon as the dew is off, and run until noon or until as much has been cut as can be handled in the afternoon. As soon as the top of the cut vines is well wilted the field is run over with a tedder to turn the vines over and expose them more thoroughly to the air and sun. When the crop is very heavy the tedder is used a second time, though this is seldom necessary. Vines which have been cut in the morning and tedded in the afternoon are usually dry enough to put into small cocks the next afternoon, and if the weather promises to be favorable they are left to remain in the cocks 2 or 3 days before they are hauled to the barn. If it should rain before the vines are put in cocks they are not touched until the surface is well dried off, and then tedded as though freshly cut. Those which are in cocks are not opened until well dried on the outside, and are then handled as little as possible to secure a thorough airing. A light rain does very little damage to the hay, even after the curing has begun, if handled promptly and properly, and a heavy rain for a day or two may fall on freshly cut vines and do little or no damage. The essential point in making hay is to do the work as rapidly as possible, and avoid any handling of the vines when wet with either dew or rain. We find that it pays well to use a tedder for stirring up the freshly cut vines so as to admit sun and air freely, though if a tedder cannot be had the work can be done nearly as well, though more slowly, by using a fork.

"It is not safe to bale the vines direct from the field. Of course that is the most

convenient plan, but, as in many other cases, the quickest way is not the best. Although the field cured hay may appear and feel perfectly dry, it still contains a considerable amount of moisture, and if packed closely at once, it is sure to undergo a heating and fermentation, the escape of the heat and moisture is prevented, and decay is the result. We find the only safe plan is to put the hay, for a few weeks, into a stack covered with straw, or, still better, into a barn, where it should not be piled too deep. After a month it may be packed without danger of finding moldy or dusty hay in the centers of the bales."

Somewhat different from this is the method of curing advocated by Prof. W. F. Massey of the North Carolina Station. He advocates putting the hay into the barn when it has dried out enough so that if a handful of the vines is taken and twisted hard no juice runs out. When once in the barn the vines should not be disturbed, but allowed to heat and cure with as little contact with the air as possible. It is not necessary or advisable to rake the vines into windrows and cock. When cocked they are more liable to mold at the second handling in the barn. The vines should be simply left on the ground until they are in the half cured condition and then hauled in while still limp. Thus treated all the leaves are saved and a good green well cured hay secured.

The bush varieties are considered best for hay because of the greater ease with which they can be mowed and handled. A stack frame for curing cowpea vines has been devised by the Arkansas Station. The frame is essentially a series of shelves made of poles or rails placed 12 inches apart and resting on horizontal supports 2 feet apart. The wilted pea vines are piled on the bottom rails 2 feet high; the second shelf of rails is then put on and more pea vines added etc. Care is taken to keep the sides of the stack perpendicular, as the vines will not shed rain. The top of the stack should be covered with straw or something to turn water. Hay thus put up cured perfectly and was of a bright green color and of excellent quality. In using the hay take that from the lowest shelves first.

Cowpea seed is harvested by picking off the pods when they are ripe and threshing either with a flail or by machine. Sometimes the vines are run through a thresher, from which the concaves and the alternate teeth of the cylinder are removed; but this breaks and bruises many of the seed and is not generally practiced. Usually farmers gather only enough peas to seed the following season. Fully 95 per cent of the peas placed on the market are hand picked.

Use as Green Manure. As noted above, the most economical way of using cowpeas is to feed the vines and peas to stock and return the manure to the soil. When this cannot be done the whole crop is often plowed under. On heavy clay soils which need loosening the vines should be turned under green. The heavier the crop turned under the greater will be the beneficial action on the mechanical condition of the soil. On sandy soils which are already too light the vines should be grazed and left on the surface to decay. Where the vines are plowed under the operation should be done in the fall and the ground immediately followed by some winter growing crop, such as rye, wheat, winter oats or vetch. The roots of these growing plants catch and hold the foods liberated by the decaying vegetable matter in the soil and thus prevent winter leaching and washing. The following spring the green cover crop can be plowed under and the regular crop of corn, cotton or small grain grown. Where it is not practical to grow this winter cover crop it is best in practice to let the vines lie on the ground over winter. This prevents the washing and leaching of the soil that would occure on freshly plowed ground.

From analyses made at a number of experiment stations it has been clearly shown that an average crop of cowpeas turned under will add to the soil more than 110 pounds of nitrogen per acre.

Feeding Value. In a general way it may be stated that cowpea hay is about equal in feeding value to good clover or alfalfa hay. It is especially rich in blood, bone and muscle-making material. Hogs do especially well on cowpeas. An acre of ripening peas will pasture from 15 to 20 young hogs. Where it is intended to turn the vines under for green manuring it is advisable to first pasture with hogs. The droppings of the hogs will enrich the soil and a large amount of firm pork of excellent quality can be secured. Pigs also relish the cured hay, and it should be fed to fattening hogs in addition to the corn ration.

The place of the cowpea in rotations will depend on whether it is to be used as hay or for green manure. In Texas a favorite rotation is wheat, cowpeas, corn, cotton. In Oklahoma a 3-year rotation in

common use is corn, cotton or Kafir for the first year, followed by cowpeas and wheat. Cowpeas are much grown for hay in mixtures with sweet sorghum, Kafir, Sudan grass, Johnson grass, soy beans or millet.

The seed of the cowpea is often attacked by the cowpea weevil and the 4-spotted bean weevil. These pests may be controlled by fumigation of the seed with carbon bisulphid as mentioned for granary insects under wheat or by soaking the seed for one minute in boiling water. The seed will be injured if kept in the water for a longer period.

FLAX (*Linum usitatissimum*)

Flax has been cultivated from the earliest times, being mentioned in Exodus, and used in making the cloth wrappings of Egyptian mummies. Flax for fiber was raised for hand spinning in farm homes from early colonial days to about 1850 when hand spinning wheels went out of use. Flax is now raised chiefly for seed and mostly in the Dakotas, Minnesota, Iowa, Montana and California, with a total area of 3,400,000 acres, and a yield of about 31,400,000 bushels of seed. The climate of the Willamette Valley, Oregon, is well adapted for flax fiber production, with abundant moisture in spring and a dry season from June to September, which cures the flax to a golden yellow, and furnishes good weather for drying the retted straw. A heavy growth takes place in the Great Lakes region, but the straw is coarse and the fiber inferior in strength. Recent experiments in Georgia indicate the possibility of profitable culture of flax in that State.

According to A. C. Dillman of the Department of Agriculture "Flax requires a firm seedbed. Poor stands often are due to seeding too deep in loose soil. Sod broken in the fall or spring should be packed by heavy rolling or by disking, harrowing and rolling, and the surface should be made level before being seeded. Sod land should be prepared as soon as possible in the spring in order that the seed may be sown before the turned sod becomes dry. Where tractor outfits are used, plowing, disking, harrowing, packing, and seeding often are done in one operation. Pasture and meadow lands usually should be broken late in the summer. The rough sod will catch and hold the snow, frequent freezing and thawing will mellow the sod, and the land can be put in condition for early seeding."

A firm seedbed is as essential when flax is grown in rotation with other crops on old land as it is on sod land. For this

FLAX IN OREGON

reason corn ground usually is disked instead of plowed in preparation for flax. If spring plowing is necessary, the land should be made firm by rolling or disking, with the disks set nearly straight.

Method of Seeding. "Flax generally should be sown with a grain drill at a depth of about 1 inch. A drill with press attachments is most satisfactory, as it presses the moist soil around the seeds, thus insuring even germination. When it is necessary to sow on loose soil, it is sometimes desirable to release the pressure springs on the drill and depend on the weight of the disks to place the seed at the proper depth.

"In seeding wheat or other grain with flax, the two kinds of seed are mixed in the desired proportions at the granary and sown together about 1 inch deep. Usually alfalfa or clover is sown with a grass-seeding attachment to the drill, although the seed of these plants can also be sown readily when mixed with flax."

In the northern Great Plains region flax seeded early in May gives the highest yields, but it may sometimes ripen before frost if sown the first week in June. The rate of seeding is usually 2 or 3 pecks per acre, the larger amount on irrigated land.

Flax has been raised for 40 years or more in Washington, Oregon and Idaho, and more recently has assumed some importance in the Imperial Valley, California. The stout Argentine type of flax seems adapted to the Imperial and Sacramento Valleys. Punjab, Golden and Abyssinian flaxes also give much promise in California.

Crop Rotations for Flax. "Flax is grown to best advantage in rotation with clean-cultivated crops or on fallow land kept free of weeds. It does well following beans, peas, corn, sugar beets and other clean-cultivated row crops. Alfalfa, clover, wheat or barley land also is suitable for flax, provided it is free of weeds.

"Grain sorghum, sorgo, Sudan grass, and millet should not be followed immediately by a flax crop. Sorghum land should be fallowed for a year, or sown with a leguminous crop for soil improvement before being sown to flax. The legume may be grown either as a winter or summer crop. Some suitable winter crops for use on sorghum land are field peas, vetch, sourclover and fenugreek. If summer crops are preferred, cowpeas, soy beans, guar or sesbania may be used. The choice of crop should depend on soil and climatic conditions and whether it is grown for feed, or only for soil improvement. The injurious after effects of sorghums, including Sudan grass, may be very serious and result in crop failure if flax is seeded before the sorghum roots and stems have decomposed and soil fertility has been restored.

"Flax may follow flax, but when this is done a quick-maturing clover crop usually is grown during the summer and turned under before the land is prepared for the second crop of flax. For example, in the Imperial Valley of California, where flax is harvested in May, the land may be prepared immediately by disking and seeded to sesbania, guar, cowpeas or soy beans. With plenty of water for irrigation, these crops will be ready to plow under in 60 to 90 days. This allows ample time for the green manure to partly decompose before flax is seeded again in November. When this practice is followed, flax may be grown on the same land for a number of years without diminishing yields. This cannot be done, however, on nonirrigated or dry land. Although flax can be grown for 2 or more years on the same land, as a general rule, it can be grown to best advantage in a regular crop rotation where the land is relatively free of weeds and fairly well supplied with nitrogen, as following a legume, and where a firm seedbed can be prepared at small expense."

Flax has only a slim chance in competition with weeds. It is useless to seed flax in weedy land. One or 2 cultivations in spring before sowing flax should be a regular practice.

Until recently the common method of harvesting flax was to pull the plants by hand, but mechanical pulling machines have been devised and are in general use in Oregon. If the crop is grown for producing upholstery tow, it may be cut with a mower and allowed to lie on the ground a few days before being hauled to the mill. "The farmer delivers the straw for fiber at the scutching mill. The processes of preparing the fiber from the unthreshed straw require special apparatus and must be carried on by men with skill and experience in this particular work in order to produce uniform fiber acceptable to flax spinners."

Usually only the poorest fields are used for tow and the yield in such cases is about 1½ tons cured straw per acre. The yield of fiber flax averages about 1¾ tons per acre. Wilt is the most destructive disease of flax, sometimes destroying the whole crop. The spores of this disease remain in the soil and attack the flax

roots. Wilt has been the cause of the constant migration of flax from one section or State to another in search of new uninfected soil. Wilt-resistant varieties of flax have been bred. Good rotations for prevention have been worked out in which flax comes only once every 5 years. If a field once becomes infected it should not be planted again to flax for at least 10 years.

GRASSES

There is a vast number of grasses native and otherwise growing in this country which stock pasture upon; but the number of really important cultivated hay grasses scarcely exceeds a dozen. East of the Mississippi, timothy is grown to the practical exclusion of all other hay grasses. Next in importance as a hay grass is redtop or Rhode Island bent, which is also present in most meadows. Kentucky bluegrass or June grass, as it is sometimes called, is pre-eminently the cultivated pasture grass of the United States. Bermuda grass is extensively grown in the Gulf States. Other grasses that are much written about but less grown are orchard grass and the various fescues and brome grasses. These grasses and a number of others adapted to the dry regions of the West, lowlands, marshes, permanent meadows, etc., are noted in detail under separate headings below.

Grasses are seeded either with or without a nurse crop, sometimes alone, and sometimes mixed with other grasses. Timothy is quite generally grown with a small proportion of red clover added. These plants supplement each other well, since the timothy is a surface rooted plant, while the clover sends its roots down much deeper, bringing up plant food from the subsoil. The quality of the hay is also greatly improved by the addition of the clover. Grass mixtures are not generally advised where hay is grown for market. In permanent meadows and pastures, however, it is generally advisable to seed mixtures of a number of grasses to insure an abundance of herbage at all seasons of the year.

Bent Grasses. These include the Rhode Island bent (*Agrostis canina*), creeping bent (A. *stolonifera*), common redtop (A. *vulgaris*) and a number of other less well known grasses. All are very similar in habit of growth. They are perennials 2 to 3 feet high and grow from creeping rootstocks. The roots closely interlace and form one of the most dense sods known. The chief value of these grasses is for pasture, especially for dairy farming. They stand the tramping of stock well and are especially valuable for making good pastures in sandy, moist places where it is too marshy for other grasses. They may be overflowed and covered with water for 2 to 3 weeks without injury. On drier soils very good pastures are also made. On rich lowlands redtop sometimes grows 4 feet high and yields 3 tons of hay per acre.

These grasses are cultivated chiefly in the Eastern and Middle States as far South as Tennessee. Experiments at the experiment stations show that they are well adapted to nearly all parts of the United States, growing a little taller in the South than in the North.

As a hay crop the bent grasses are not very satisfactory. The yield is light, varying from ½ to 2 tons of cured hay per acre. The crop should be cut just before the seed matures. They are easily seeded either alone or with other grasses, particularly timothy, and maintain themselves well against weeds. Seeded alone 1 to 2 bushels per acre are required. The method of seeding is that observed with timothy. They require 2 or more years to become thoroughly established, and are therefore not satisfactory in rapid rotations. Rhode Island bent and creeping bent are both excellent lawn grasses. For this purpose the former should be seeded at the rate of 3 to 4 bushels per acre and the latter 3 bushels.

Bermuda Grass (*Cynodon dactylon*). A low perennial grass having a creeping habit of growth. It roots at the joints and forms a close sod. The leaves at the base of the plant are short and numerous and the upright flower stem on poor soils only a few inches high. On richer soils the nearly leafless stems may grow 1 to 2 feet high. It is a native of the tropics and produces seed in quantity only in the extreme southern portions of the United States. Bermuda is one of the most valuable pasture grasses of the South and is propagated to some extent on the Pacific coast. It is very resistant to heat and drouth, but will not thrive in the shade, and is very susceptible to hard frosts. It is not profitably grown north of Virginia and Kentucky.

As a hay plant it may be cut 3 or 4 times each season, and under ordinary conditions will yield 1 to 2 tons of nutritious hay per acre. It is pre-eminent, however, as a summer pasture crop, flourishing where other grasses are parched and dead and withstanding grazing and

the trampling of stock better than any other grass. Bermuda grass will grow on nearly all soils unless too moist. It prefers rich, sandy and alluvial soils. It is propagated either by seed or by sowing or planting the chopped sections of the rootstocks. Seed is rarely used. The roots for sowing are prepared by shaking the dirt from them and running them through a cutting box. These cuttings, about an inch long, are sown broadcast and lightly harrowed in. Sown with oats, the grass is ready to occupy the field as soon as the oats are harvested. Pieces of Bermuda grass turf may be used in the same manner. The grass spreads very rapidly and soon completely occupies the whole field. It should be cut early and often for good hay.

Bermuda grass once established is very persistent and is a troublesome weed in tillage, and should be used mostly for permanent pastures. It can be eradicated by shallow fall plowing so as to expose the roots to frost, followed by cotton with clean cultivation and cowpeas for 2 or 3 seasons. The grass is especially valuable in lawns not too far north as it remains green when all the other grasses are parched and yellow. It turns brown, however, with the first heavy frosts. It is particularly valuable for binding drifting sands and to keep the soil from washing.

Big Blue Stem (*Andropogon provincialis*). A stout perennial 2 to 6 feet high, with numerous long, rough margined leaves and flowers in 2 to 5 short spikes at the apex of the stem or its branches. It has a wide range east of the Rocky Mountains along river bottoms and such places and is particularly abundant along the Mississippi River. It is well liked by stock both as green forage and as hay. The Iowa Station states that it is an important factor in the hay production in the northwestern portion of the State and brings a higher price in the market than any other wild hay, and that for horses many farmers prefer it to timothy. It starts late in the spring and the early growth consists of an abundance of long, succulent leaves. The plant should be cut in early bloom for hay. If not cut until fully matured the stems become hard and woody and the hay is of inferior quality. It is said to mature seed rarely. Blue Stem thrives on poor, sandy and rocky soils as well as on the richer prairies.

Little Blue Stem (*A. scoparius*) grows in bunches and is common on the prairies, especially on the poorer, sandy soils. It is valuable for hay, but is not so productive as the big blue stem. It is useful as a fall pasture plant.

Blue Joint (*Calamagrostis Canadensis*). A native perennial grass common in low, moist meadows or wet, boggy grounds in the Northern and Northwestern States west to the Pacific. The smooth, hollow stems are 3 to 5 feet high and bear open brown or purplish panicles much resembling redtop. The leaves are rough, about a foot long and half an inch wide. The plant spreads by underground shoots and is sometimes found occupying considerable areas to the exclusion of other grasses. It seeds sparingly. The hay made from it is highly prized by farmers, being nearly as good as timothy and readily eaten by all farm stock. It grows naturally in low, moist meadows, but has succeeded well under cultivation. It should be cut early for the best hay.

Brome Grass (*Bromus inermis*). Smooth, Awnless, Hungarian or Australian Brome Grass, as it is variously called, was introduced into this country from Europe about 60 years ago. It is a vigorous, hardy perennial, with strong creeping rootstocks and smooth, upright leafy stems 1 to 4 feet high, having loose open panicles 4 to 8 inches long. It is valuable for both pasturage and hay. Extended cultural tests throughout the country show that it has remarkable drouth-resisting qualities and is the most suitable grass yet introduced for the dry regions of the West and Northwest. Once established, it withstands a temperature many degrees below zero without injury. It will thrive on extremely poor, sandy lands and return a fair crop. On better soils it grows rapidly, producing an abundance of pasture and yielding from 1 to 4 tons of cured hay per acre. All stock relish it, and at the North Dakota Station it gave better results in feeding experiments with horses than good timothy hay. As a pasture grass for milch cows it gave excellent results at the Nebraska Station.

That station says of it that "all things considered, *Bromus inermis* is the most promising cultivated pasture grass for this State that has been tested on the station farm. After once having become established it is unaffected by cold. During periods of extreme drouth it lessens growth, but does not die. Its advantages over the native grasses are that it becomes green fully a month earlier in the spring and does not dry up in summer. It also remains green late in the fall. In-

dications are that it will carry more stock to the acre than most of the prairie pastures. It does not make a good mixture with other grasses, but does well with red clover. As a pasture for dairy cattle it is not equal to a mixture of blue grass and white clover, nor by any means equal to alfalfa as a milk and butter producer, but it is absolutely safe. Tests throughout the State indicate that it is adapted to a greater range of territory than any other cultivated grass." In South Dakota it has proved the best pasture grass tested.

In a comparison of brome grass with timothy at the North Dakota Station the brome grass far outyielded the timothy, one year producing ¾ to 1½ tons per acre when timothy was a total failure from drouth. Analysis showed that brome grass hay contained about twice as much protein as the average analyses of timothy for the whole country, and about the same amount of fiber. An examination of the roots showed that while those of timothy extended downward but 3½ feet, the brome grass roots went down 5 to 6 feet and were much greater in bulk. The brome grass was found to be a better humus former than timothy and left the soil in better chemical and physical condition.

Brome grass is best seeded broadcast at the rate of 18 to 20 pounds per acre without a nurse crop. The land should be well prepared by plowing and harrowing and the seed sown in the spring or even as late as August 1. In some parts of Oregon, California and Washington fall seeding in October or November has been found best. It should be cut for hay when in full bloom and handled like timothy.

There is one caution to be observed. Since the plant propagates itself by creeping rootstocks, it is liable to become a weed, and is best used in permanent pastures. However, it can be readily eradicated by giving attention to good culture.

Buffalo Grass (*Buchloe dactyloides*). One of the most valuable wild grasses of the great plains. It is a low plant, the bulk of the leaves seldom rising more than 3 or 4 inches about the ground. It grows in extensive tufts or patches and spreads largely by means of runners. These are sometimes 2 feet long, with joints every 3 or 4 inches, which form roots and send up flower stems. The flowers are mostly dioecious, but sometimes both male and female flowers are found on the same plant. The grass is very nutritious. It is reported to seed well or to grow from cuttings of the runners. The low growth of this grass makes it valuable only for pasture or lawns and more particularly in those regions where it grows naturally.

Carpet Grass (*Paspalum compressum*). A Southern grass native along the coast and common in Mississippi and Alabama. It is also especially abundant on the prairies of Louisiana and is sometimes called Louisiana grass. It is a low, creeping perennial, too short for hay, but considered one of the very best pasture grasses for sandy soils in the South. The plant roots at the nodes and sends up numerous flower-bearing branches 6 to 24 inches high, which bear 2 to 3 slender spikes at their summits. On the heavier soils Bermuda grass may crowd it out, but on moderately fertile, light soils it quickly covers the ground, forming a thick carpet of grass to the exclusion of all other weeds and grasses. It withstands the tramping of stock the best of all Southern grasses, withstands drouth well, is unaffected by frosts, and in the more Southern districts remains green all winter. On the lighter soils where Bermuda grass will not do well it makes an excellent lawn grass and is often used for this purpose. Seed is seldom found in the market. The plant is usually propagated by cutting the hay when the seed is ripe and scattering it over the freshly cultivated field. Where a few plants grow the grass is soon scattered over the whole field by stock and otherwise. The grass is easily destroyed by cultivation and is not dangerous as a weed.

Crab Grass (*Panicum sanguinale*). This annual grass is common in nearly all parts of the United States and is a weed in many gardens and fields. In the Southern States it is especially abundant, and when cultivation ceases or after harvesting a grain crop, it frequently springs up in such quantity as to afford 1 or 2 good cuttings of hay. It grows from 2 to 4 feet high, the stems are much branched and bear 3 to 12 slender purplish flower spikes. The stems are usually bent at the base and roots are frequently thrown out at the lower joints. The grass prefers a rather moist soil. It is never sown, but comes up spontaneously when cultivation of other crops ceases, forming excellent pasture in the South from June to October, or until heavy frosts come. It makes a hay much relished by stock, and for this purpose it should be cut before the seed ripens. The hay is easily cured in dry weather and is of good quality; but is easily leached of its nutritive qualities by rain. It does not shed rain

well, and if stacked in the open field should be capped with some other grass. Two or more cuttings per season are usual.

Cord Grass (*Spartina cynosuroides*). This is a coarse perennial native grass found along the shores of the ocean, lakes and rivers throughout the northern half of the United States. It grows 2 to 6 feet high, with many flat, long pointed leaves and numerous erect or spreading spikes, 2 to 5 inches long. Cut early it makes a fair but rather coarse hay. It has creeping rootstocks and is considered valuable as a sand binder and for thatching.

Crested Wheat Grass (*Agropyron cristatum*). A hardy perennial bunch grass with a comb-like spike of flowerets, flat leaves 6 to 10 inches long, and tufted stems 18 to 36 inches high. The roots extend downward 3 to 10 feet and laterally at least 4 feet. It is well adapted to the Great Plains as far south as Kansas and also to Oregon and Washington. It has proved the most drouth resistant and hardiest of the domesticated grasses. This grass is highly palatable, makes excellent hay, starts early in the spring and has 2 to 3 times the grazing capacity of the native range. It becomes dormant during midsummer but greens up again in the fall and furnishes late pasturage. Crested wheat grass spreads naturally by seed and by rootstocks from the many tillered bunches.

Fowl Meadow Grass (*Poa flava*). A native grass found in wet meadows and low bottom lands in Northeastern United States. It grows 2 to 3 feet high. The leaves are narrow, 3 to 6 inches long; panicle rather dense and 6 to 14 inches long. The name, fowl meadow grass, is derived from the supposed introduction of this grass by water fowls in the low meadows at Dedham, Massachusetts. False Redtop is another name given to it, due to its great resemblance to that grass and the fact that they are usually found growing together. It may be distinguished from redtop, and also from the closely related blue or June grass, by the absence of running rootstocks.

Fowl meadow grass makes a hay of good quality. The stem remains green and succulent after flowering, so that the crop need not be cut for hay until the seed is mature. This permits of the gathering of a crop of seed and of straw at the same harvesting. The second growth starts slowly like timothy and is not, therefore, well adapted to pasture. Fowl meadow grass will grow on nearly all well cultivated land, but prefers a moist situation. Seeded alone it makes a poor sod. Its slender stem and heavy tops incline it to lodge. Some other stronger growing grass, like redtop, should, therefore, be grown with it.

Gama Grass (*Tripsacum dactyloides*). This is a coarse native perennial grass 3 to 8 feet high, with many broad leaves resembling in size and appearance those of corn, and large creeping rootstocks. It is very succulent when cut green and is eaten greedily by stock. The Tennessee Station considers it valuable for soiling, forage, or the silo, and states that while it naturally grows in swampy places, it will thrive almost equally well on dry or sandy ridges. It is native from Connecticut to Kansas and South to Florida and Texas. The seed vegetates with difficulty and the plant is therefore best propagated by root cuttings. In planting, rows should be made about 2 feet apart and the cuttings placed 1 foot apart in the rows. The grass may be cut 2 or 3 times a year and produces an enormous amount of forage. It should always be cut before the seed stalk is sent up if desired for hay. It is an attractive plant for lawn decorations.

Grama Grass, Mesquite Grass (*Bouteloua* spp.). The blue or white grama (*B. oligostachya*) is one of the most abundant and valuable of these grasses. It is a perennial 6 to 18 inches high, with numerous narrow root leaves. It is native to the plains from Wisconsin west and south to California and Texas. It resists drouth and the tramping of stock well and is unsurpassed for grazing wherever it grows in these regions. It cures into good hay while standing, like buffalo grass, and is used for this purpose where found in sufficient quantity. Black grama (*B. eriopoda*) is especially abundant in Texas and New Mexico and forms one of the most valuable grazing grasses of that region. It grows 1 to 2 feet high, often forming a dense turf, and is distinguished by having woody, jointed stems.

Tall grama or **Side-oats** (*B. curtipendula*) has a wider range of territory, being native from New Jersey west to the Rocky Mountains and south to Mexico, and is one of the tallest gramas, ranging from 1 to 3 feet. It is a perennial, with tough, fibrous roots, long, narrow leaves, with the numerous spikes arranged one-sided along the upper portion of the stem. It grows in bunches. It cures readily, making a hay of excellent quality. Under cultivation at the Iowa Station it made a good stand, in one season producing a fine,

even turf 6 inches to 2 feet high, and in the autumn had developed sufficiently to produce 1 to 1½ tons of hay per acre. It is considered well worthy of cultivation on dry soils.

Johnson Grass (*Andropogon halepensis*). This grass was introduced into this country from the old world about 1830, and is now well distributed throughout the Southern States. It is a rank growing perennial 3 to 6 feet high, with numerous long leaves, panicles 6 to 12 inches long, and strong creeping rootstocks. It thrives best in calcareous and especially rich alluvial soils, but will grow on the poorest soils, withstanding all drouth. It is especially valuable for hay, giving 2 to 3 cuttings a season, with a total yield of 3 to 5 tons per acre. The hay is coarse in appearance, but rivals timothy in quality and is greedily eaten by stock.

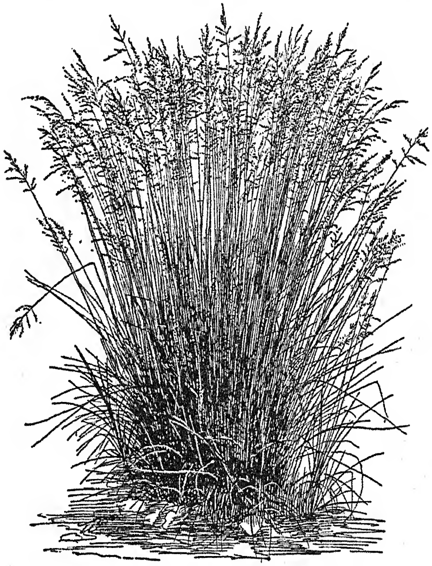
Johnson grass possesses no merit for pasture. Since it starts growth late in the season, the tops are killed by the first fall frosts and the fleshy rootstocks are so near the surface of the ground that the trampling of stock seriously injures them, causing the plant to practically disappear from the field. These rootstocks are greatly relished by hogs and are considered by the Tennessee Station equal to artichokes for hog feeding.

For hay the crop should be cut before the heads appear. When grown from seed it requires about 1 bushel of seed per acre, or root cuttings may be set a foot apart either way. After the plant has been cut for hay for 3 or 4 years the roots become so matted that the yield is decreased. The field should then be plowed up either in winter or early spring and thoroughly harrowed, after which the grass will grow in all its original luxuriance.

Johnson grass is the most prolific perennial grass grown in the South, and at the same time it is one of the most serious weed pests. Once established it is almost impossible to eradicate it. Persistent and continuous cultivation from early spring to late fall may kill it on poor, sandy lands if it is continued for a season, but it is likely to survive this treatment on the better soils. Ball recommends the summer plowing of fallow land during the 2 hottest and driest months of summer as the best means of killing it. The first plowing should be about 2 inches deep. The second plowing should be about 2 inches deeper and crosswise of the field. Johnson grass may practically disappear from a field when pastured for a number of years, but the roots remain alive and the plant will immediately reappear in luxuriance when the field is again brought under cultivation. Salt has been recommended to destroy it, but has little value, even when the plants are covered half an inch deep. The plant is so difficult to eradicate that it should never be sown in the South on clean land that is ever intended for any other purpose. "If it is already established on the land it is often better to encourage it than to fight it, as a heavy crop of good hay is more profitable than an ordinary crop of either corn or cotton."

The plant has been grown in Nebraska as an annual from Southern seed with some success.

Kentucky Blue Grass (*Poa pratensis*). This grass is also known as June grass, spear grass, meadow grass, pasture grass,



KENTUCKY BLUE GRASS

etc. It is native from South Carolina west to the Pacific and north to Alaska and Labrador, but attains its greatest perfection in the limestone regions of Kentucky and Tennessee. There it is the king of pasture grasses and these regions have become world famed as stock centers. In the Middle and Eastern States it is a prominent constituent of all permanent pastures, but it is not so satisfactory for hay as some other grasses because of its lighter yield. In the far South it has not proved very satisfactory. The plant is a perennial, growing 6 inches to 2 feet

high, with many long, narrow root leaves. It spreads rapidly by means of seed and various runners or suckers, forming a close, compact sod that withstands trampling and grazing well. It bears drouth well, and though it may appear brown and sere after a hot, dry summer, it rapidly recovers with the first autumn rains, furnishing an abundant supply of rich, green pasture. Kentucky Blue Grass does best on calcareous loams of a clayey rather than a sandy nature. It may be seeded any time of year, but preferably in the fall in September or October, or any time in the winter when the snow is on. Seeded in the fall, it should be lightly brushed in. The seedbed should be firm and compact. From ½ to 2½ bushels of seed per acre are required. This large amount is due to the low vitality of the seed offered for sale on the market. Most of it has a vitality below 20 per cent, and much of it below 10 per cent. The plant is slow to take possession of the ground, and from 2 to 3 years are required before it becomes firmly established. Once established, however, on suitable soils it endures for many years and should form a prominent part in all grass mixtures for permanent meadows. It is a favorite lawn grass and makes a firm sod that is well suited for turfing. For lawns not less than 3 bushels per acre should be sown.

Meadow Fescue (*Festuca elatior*). This grass was introduced from Europe and has become naturalized all over the United States. It is exceedingly valuable both as a pasture grass and hay and especially desirable in permanent pastures, as it is of long duration. South of Virginia and Kentucky it remains green over winter. It thrives best on rich, moist clay or marl soils, but will do fairly well on drier soils; though the Iowa Station notes that in that State it is less able to resist drouth than timothy, blue grass or orchard grass.

Its cultivation in this country is confined chiefly to the Eastern States. Meadow fescue is a perennial, 2 to 5 feet high, and usually tufted or growing in bunches like orchard grass. The roots are stout and fibrous, leaves 1 to 2 feet long and rather abundant. It is propagated from seed, sown at the rate of 2 to 3 bushels per acre in the same manner as timothy or blue grass. The grass does not become fully established until about the third year. On good soils it will yield from 1 to 1½ tons of hay the first year and double this the second. It should be cut for hay when in flower. Overflows do not injure the plant, but are said to increase its vigor. This grass should form a part of every mixture for permanent pastures. In Virginia it is known as Randall grass; in North Carolina, evergreen grass, and sometimes it is called tall fescue.

Meadow Foxtail (*Alopecurus pratensis*). A hardy perennial grass much resembling timothy in appearance, but with shorter leaves and stalk, shorter, thicker and softer spike, and

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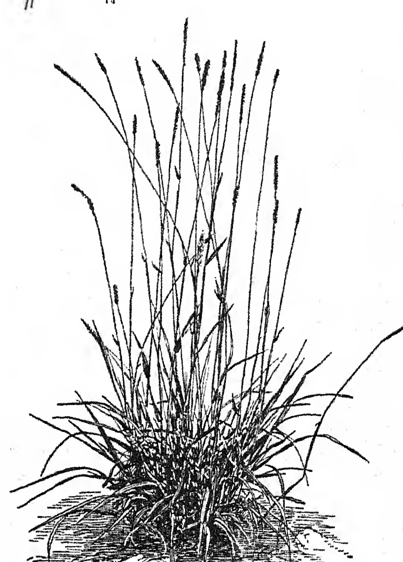
MEADOW FOXTAIL, NATURAL SIZE



MEADOW FOXTAIL GRASS PAST BLOOM

starts into growth from 3 to 4 weeks earlier in the spring than timothy. It is cultivated to some extent in the Middle and New England States, being particularly valuable as a permanent meadow and pasture grass in moist situations, where it lasts well. It is seldom grown alone, as it is 2 to 3 years in getting fully established, but should form a part of all permanent meadow grass mixtures. It makes a lighter hay than timothy, but one fully equal to it in nutritiveness. On rich soils it will yield 1 to 2 tons of hay per acre. It will stand high manuring and does not spread like June grass. Its chief value, however, is in mixtures for permanent pastures and meadows. The Iowa Station notes that it is of but little value in that State.

Orchard Grass (*Dactylis glomerata*). A popular, vigorous-growing hardy perennial grass, well suited for hay and pasture everywhere in the United States except the extreme South and the arid portions of the West. It grows 2 to 4 feet high, bearing several leaves on its stem and numerous root leaves and yields from 1 to 3 tons of hay per acre. The aftermath is abundant, and with 5 or 6 days' growth furnishes a good bite for all stock. It endures shade well and is therefore suited for culture in the open woods and orchards. Orchard grass thrives in all moderately rich soils not too retentive of moisture. It responds promptly to top-dressings of barnyard manure. For hay it should be cut when in bloom or just before, as otherwise it becomes woody. In favorable seasons 2 to 3 cuttings can be obtained.

The seed may be sown either in the fall or early spring. When sown alone 2 to 3 bushels are required per acre. It should be seeded broadcast and lightly harrowed in. A good pasture is obtained the first season. It is in mixtures, however, that orchard grass is most useful. It is especially adapted for seeding with clover. When seeded alone the grass has the fault of growing in bunches or tufts. This can be remedied in a measure by thicker seeding, combining in mixtures and rolling. In old meadows spring harrowing and rolling are recommended. Experiments at the Rhode Island Station indicate that orchard grass is greatly benefited by liming.

When seed is desired instead of hay the crop should be cut with a reaper and the bundles set up in shocks like wheat, except that no sheaf caps need be put on. It should be threshed directly from the shock rather than stacked, to avoid as much as possible shattering of seed.

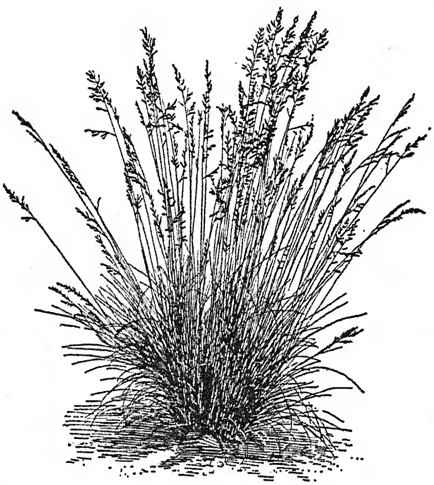
Orchard grass is especially desirable in permanent pastures, as it starts into growth very early, endures drouth and the trampling of stock well, grows rapidly and produces an abundance of herbage greatly relished by all farm animals.

Reed Canary Grass (*Phalaris arundinacea*). This is a tall, leafy perennial grass native to low meadows and marshy lands, throughout the Northern States and Canada. It grows from 2 to 4 feet high. The leaves are 6 to 10 inches long and about ½ inch wide. Panicles branching and 4 to 8 inches long. It is little affected by either drouth or cold and will do well in the shade. It makes a fair coarse hay. The Iowa Station states that it succeeds admirably under cultivation even in dry soils, and at the station resisted drouth as well as any grass under cultivation. It prefers stiff, wet lands and flooded situations. It is propagated either by seed or by rootstock cuttings. The cuttings should be placed about a foot apart and lightly covered. Two years are required before the cuttings come to full maturity. For hay the grass should be cut before flowering, otherwise it becomes woody and hard.

Rescue Grass (*Bromus unioloides*). This grass is also known as Schrader's brome, Australian brome, Australian oats, Arctic grass, etc. It grows 1 to 3 feet high and much resembles chess in appearance, to which weed it is closely related. It is naturally an annual, but if prevented from bearing seed by close grazing or frequent cutting it will live several years and produce well. In the South, where it is grown to a considerable extent as a winter grazing grass, it is the common custom to seed it in August or September at the rate of 30 to 40 pounds of seed per acre. By January or February it will furnish an abundance of pasture until spring, when it should be allowed to ripen seed and thus reseed itself, after which a crop of cowpeas, crab grass or Japan clover may be grown. When these crops are removed in the fall the rescue grass will again come on and furnish winter pasture. The essential factor in this method of growing the grass is to permit it to reseed itself each spring. If this is not done the grass dries up during the summer, the use of the ground is lost and the plant soon runs out. In the cooler regions the grass should be sown in the spring. It will then remain green until late fall. It does well on almost any soil, but prefers a rich

loam. Under favorable conditions it will give 2 cuttings per season, yielding 1 to 1½ tons per acre of hay of good quality.

Rye Grasses. The more common of these grasses are the Italian rye (*Lolium Italicum*) and Perennial rye (*L. perenne*). These are European grasses, and, while very popular, they have not proved especially desirable here except in a few localities. The Italian rye grass is a biennial, and therefore not suited for permanent pastures. It flourishes best in the Eastern States and particularly in the region from southern Pennsylvania to Virginia, requiring for its best growth moist, loamy lands of a calcareous nature. On such soils it is an excellent hay grass and grows very rapidly when regularly fertilized with either barnyard or liquid manure. Cuttings may be obtained 4 to 6 weeks after seeding and at similar intervals thereafter throughout the season. This rapidity of growth taken in connection with the succulent character of the grass, makes it especially valuable for soiling purposes. The grass does not withstand drouth, nor does it do well on stiff clays. The plant grows in broad, compact tufts about 2 feet high or more and produces a number of stems from a single root, which bear an abundance of long leaves. It is distinguished from Perennial rye grass by having awned or bearded spikelets.



SHEEP'S FESCUE GRASS

For hay rye grasses should be cut when in full bloom. The yield is 2 to 3 tons per acre. Seeded alone 2 to 3 bushels are required per acre. In mixtures about 1 bushel per acre should be used. Seedings may be made either in the fall or the spring. The rapid growth of these grasses soon covers the ground with a dense mat of long leaves, which, if not closely grazed or mowed, will soon rot and cause the roots to decay. The Italian rye grass will not last over 2 or 3 years at best, and is, therefore, not valuable in permanent meadows. It is most useful in mixtures like redtop or orchard grass, which increase in value as the rye grass decreases.

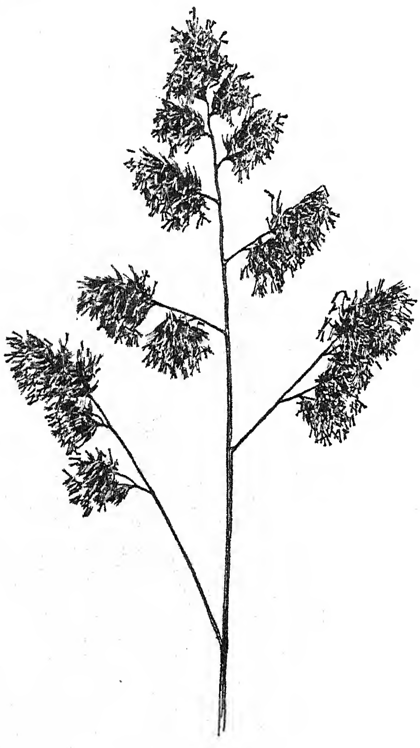
The Perennial rye differs little from the Italian except as noted above and in being longer lived. It requires similar soil and cultural methods. It will never replace timothy where timothy does well.

Sheep's Fescue (*Festuca ovina*). This fescue differs from meadow fescue only in its much smaller size. On thin soils the height rarely exceeds 8 inches, though some varieties attain 2 to 3 feet. It is native to the Northwestern States, and in some localities produces an abundance of herbage that is greatly relished by sheep and to a less extent by other stock. Sheep's fescue and all its varieties are perennial "bunch grasses," and are devoid of creeping rootstocks. It is especially suitable for culture on the lighter, drier soils of a sandy nature where other grasses will not thrive. Two and one-half to 3 bushels of seed are required per acre.

TALLER FESCUE

The grass yields too little to cut for hay and is valuable for pasture only in the drier regions of the West and on soils too poor to grow better grasses. The grass is also native in Europe and is said to be especially abundant in the sheep grazing districts of Scotland.

Sudan Grass (*Sorghum vulgare var. sudanense*) was introduced from Sudan in 1909. It is an annual under cultivation, resembling Johnson grass but without the aggressive rootstocks of the latter and



ORCHARD GRASS

therefore not prone to become a weed. Seeded broadcast or in drills it grows to a height of 3 to 5 feet, or if cultivated in rows attains a height of 6 to 8 feet. The panicle is loose like Johnson grass and the flowers are often purplish in color. Sudan grass does best in warm climates but is raised in all parts of the country. It is quite drouth resistant but yields up to 8 or 10 tons of cured hay under irrigation. Sudan grass grows erect with a stiff stem which may serve as support for legumes that are raised in mixtures with it, such as soybeans and cowpeas. Ordinarily Sudan grass is sown about 2 weeks after corn planting time, preferably by a grain drill and at the rate of 10 to 40 pounds of seed per acre. Its feeding value as hay is equal to that of timothy and it has attained great popularity as a summer pasture crop.

Texas Blue Grass (*Poa arachnifera*). This is a native Texas grass now well distributed throughout the Southern States. It is a perennial pasture grass closely related to Kentucky blue grass, but more vigorous than that plant, growing faster and to a greater height. It has a few long leaves on the stalk, creeping rootstocks with many long root leaves, and narrow, densely flowered panicles. The seed are very woolly, adhering closely, and difficult to sow. The plant forms a thick turf well suited to permanent pastures. It is especially valuable for fall and winter grazing, since it makes its principal growth during the winter months, coming into bloom in April and May. Even as far north as Tennessee it remains green throughout the winter. It withstands drouth better than Kentucky blue grass, but will not endure the severe freezes of the Northern States.

Because of the high price of the seed and the difficulty of sowing the same, the plant is usually propagated from roots. The chopped sections of the rootstocks should be planted 6 to 10 inches apart in rows 2 feet apart. The creeping rootstocks soon fill the intervening space, crowding out all weeds and wholly occupying the ground, making a firm sod within a year or two, that will withstand all tramping. September or October is the best time for planting. When the seed is planted it should be in drills a foot apart and lightly covered. Any good soil, especially calcareous loams, not too moist, will grow this grass to perfection. Its growth after fall rains is said to amount often to an inch per day.

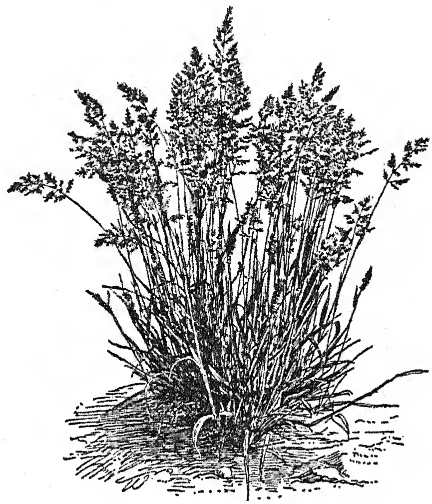
Tall Oat Grass (*Arrhenatherum elatius*). An European perennial 2 to 4 feet high, which has found favor in the North and as far south as Tennessee and Northern Georgia. It produces an abundance of leaves and tall stems, is hardy and resists drouth well but seems unsuited either for hay or green forage except in mixtures. It grows best on well drained, rich, upland loams and should be seeded like timothy, the ground being first well prepared. The blossoms appear early. The crop should be cut for hay as soon as the first of these appear. The second season it yields better than the first. Two to 3 cuttings are obtained annually and the yield varies from 2 to 4 tons per acre.

This grass should be sown only in mixtures and then should never exceed 20 per cent of the total seed sown. The hay is inferior to either timothy or orchard grass.

TALL OAT GRASS

Teosinte (*Euchloena luxurians*). A rank growing annual grass 8 to 12 feet high. It resembles Indian corn in appearance and botanically is closely related to it. The two readily cross with each other, forming fertile hybrids. It is a native of the warmer parts of Mexico and Central America and has been cultivated in various part of the South and west, but rarely produces seed north of Southern Florida and Louisiana. Under favorable conditions it is one of the heaviest forage plants ever grown in this country. At the Georgia Station it yielded at the rate of 38,000 pounds of green forage per acre, at the Mississippi Station 44,000 pounds and at the Louisiana Station over 50 tons of green forage. In New Jersey it did not yield as well as corn. At the Michigan Station it grew but 4 or 5 feet high. It gave heavy yields of good fodder at the Arizona Station, but required too much water to be desirable for that State. It is most successfully grown on rich soils where the seasons are long and there is an abundance of hot, moist weather. Elsewhere it possesses no advantage over corn. The plant tillers abundantly, sending up from 20 to 50 stalks from a single root. If harvested when 4 or 5 feet high, 2 or 3 cuttings may be obtained in a single season. A better quality of forage and nearly as great a yield can be obtained by allowing the crop to grow and cutting but once, about the middle or last of September before frost comes.

The plant contains from 8 to 10 per cent of sugar. The leaves are long and abundant and the stalks tender, so that there is no waste to the crop whatever. The forage is of the best quality, and the whole plant is greedily eaten by all stock. It makes an excellent crop for the silo or for soiling, and is especially valuable for feeding green in the summer when other forage crops are dried up. At the Oklahoma Station teosinte lost about ⅓ of its feeding value by exposure in the field over winter. This loss can be largely prevented by stacking so that only the butts of the stalks are exposed.



VELVET GRASS

The crop should be planted in May or June on good corn soil in rows 3½ to 4 feet apart and thinned to 1 plant every foot. One pound of good seed will be sufficient to sow an acre. As noted above, this crop is of especial value only in the South, and in Northern localities it is in no wise equal to corn as a forage crop.

Terrell or **Wild Rye Grass** (*Elymus Virginicus*). A native perennial grass very common in marshes and along streams and the borders of woods and thickets. It is erect, with smooth stems 2 to 3 feet high. It grows rapidly and is promising as a winter and spring pasture in the South and for woodland pastures in some of the Western States. It does not withstand close pasturing during the summer, and at present there are many

other grasses much superior to it for agricultural purposes.

Timothy (*Phleum pratense*). This is the most widely grown and popular hay grass cultivated in the United States. It is the standard hay of commerce and the one by which all others are compared. It is a perennial grass 1½ to 4 feet high. It grows best in the rich, moist loams of lowlands and gives decreased yields on lighter soils and dry uplands. Clay loams are more satisfactory than sandy loams. It grows in stools and never forms a close, compact sod. The roots are very fibrous, but feed shallow. The crop, therefore, will not withstand drouth as well as some other grasses, and for the same reason is very responsive to top-dressings of barnyard manure and other fertilizers, more particularly nitrate of soda and sulphate of ammonia. At the Ohio Station phosphoric acid proved very beneficial, and on acid soil at the Rhode Island Station lime increased the yields.

Timothy will not stand heavy pasturing. Except under the most favorable conditions, it will not endure at most over 5 to 6 years, when it will run out. It is, therefore, seldom used alone for pasture, but mixed with redtop, orchard grass or red clover. In the more moist situations alsike clover may replace the red clover. In such mixtures the timothy may endure 12 or 15 years. It is, however, preeminently a hay crop.

Timothy is seeded both with and without a nurse crop. Very good results are obtained by both methods. In dry years it is best to seed without a nurse crop. In the Eastern and Northern States it is usually seeded in the fall with wheat and in the spring with oats, and this is sound business policy. Fall seeding about September usually gives the best results in these States. In the Northwest, more particularly in the prairie regions, where the falls are liable to be dry until late, early spring seeding when the ground is more moist gives the best results. Preparation of the soil as for wheat will give satisfactory results with timothy. A compact seedbed and rolling on the lighter soils is desirable. A full crop is not secured until the second year.

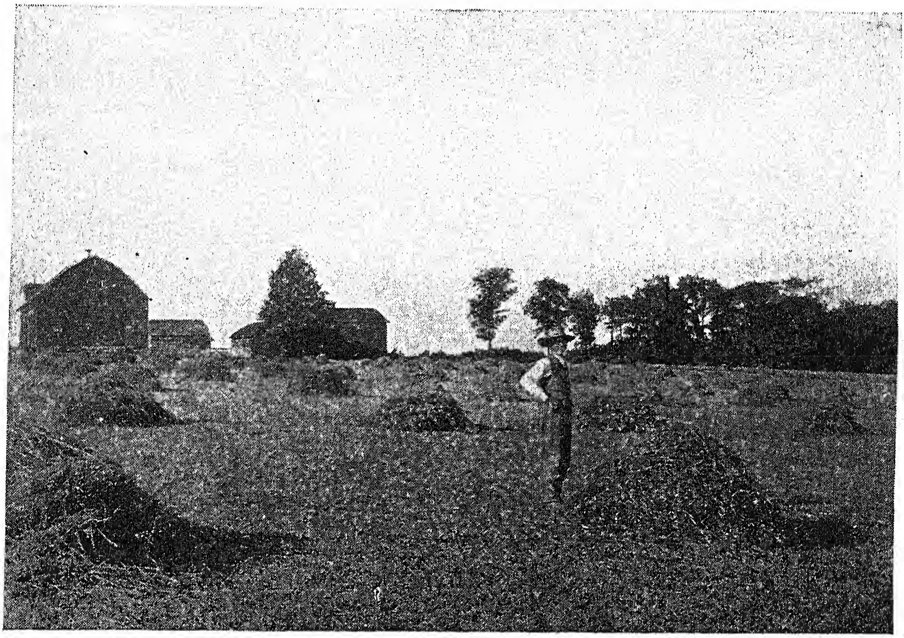
MOWING TIMOTHY

Seeded alone timothy should be put in either broadcast or with a seeder at the rate of 12 to 15 pounds per acre. In general farming in the North timothy and clover are usually mixed for seeding. Ten pounds of timothy and 4 pounds of clover seed make a good seeding per acre. At the first cutting the clover is likely to predominate in the hay, but at the second and subsequent cuttings the timothy will be in excess. About the third year the clover will disappear entirely. If the

hay is to be sold the price will increase in proportion to the timothy it contains. Nevertheless, for home use the addition of clover is very desirable, not only on account of the improvement of the land but also because the mixture makes a much more nutritious hay than timothy alone.

Timothy should be cut for hay when well past the blooming period and many of the blooms have begun to fall. The directions for haying given for red clover

lakes from Texas north into Canada, furnishing a considerable supply of food for water fowls and reed birds, and is often sown by hunters for the purpose of attracting such game. Relative to its culture the United States Department of Agriculture states that it grows very rapidly in 1 to 3 feet of water and matures its seeds in August or early in September. It succeeds best when the fresh undried seed is sown in the fall broadcast



TIMOTHY IN THE COCK

apply also to timothy. (See under Clover.) The yield varies from 1 to 3 tons per acre. Experiments at the Michigan Experiment Station indicate that timothy hay shrinks in the barn during storage 7 to 21 per cent in 6 months, depending on its dryness when put in the barn. When seed is desired the crop should be allowed to stand until the heads are brown and the seed ripe. It should then be cut with a reaper and the bundles put in shocks and left to cure for a week or more. It should be threshed direct from the shock to avoid scattering the seed. The yield varies from 6 to 12 bushels per acre and weighs 45 to 48 pounds per bushel.

Wild Rice (*Zizania aquatica*). This is an erect annual 3 to 10 feet high. It grows in shallow water along rivers and in 2 or 3 feet of water having a muddy bottom. If sown in spring the seed should be kept over winter in fresh running water. The dried seed is on the market. It germinates very poorly. Before sowing soak the seed in water 24 hours. The seed can be obtained from seedsmen for about 25 cents per pound. The grain is gathered to a considerable extent in the Northwest by the Indians for food.

In the states west of the Mississippi a large number of native grasses of more or less value for hay, pasture, green manuring or soil-binding purposes have been studied for many years under experimental conditions and in native pastures and meadows. About 100 species in the Great Plains have been recognized as of some forage value since the time of the earliest explorers. In other parts of the United

States, the native flora contributes many additions to the list of worth-while pasture plants in woodland and other uncultivated grazing areas. It would lead far outside the purposes of this volume to consider them all in detail.

sinous gum. Before the fiber can be separated the gum has to be dissolved either by putrefactive fermentation, as with flax, or by some alkaline solvent. The pure fiber is white and of a silky fineness and adapted to the production of

ALFALFA AND TIMOTHY MIXTURE

HEMP (*Cannabis sativa*)

A fiber bearing plant of first rank. It is a hardy annual, native of Western and Central Asia, and has been grown for centuries in China. Hemp was one of the first plants cultivated in this country. It is now grown to a considerable extent in Kentucky, Illinois, New York, Nebraska and in some other localities. The principal products made from it in this country are cordage, coarse cloth and binding twine.

Hemp is an erect annual, with male and female flowers on separate plants. It grows from 7 to 10 feet high in Kentucky. In the tropics the Indo-China variety reaches a height of 20 to 25 feet. The plant, while withstanding frost and drouth, revels in heat and moisture and grows more luxuriantly where these conditions prevail. South of Kentucky 2 crops of hemp can be grown yearly. Under favorable conditions the crop grows 2 to 3 feet the first month after it comes up and 3 to 10 feet the next month. From seed time to maturity requires about 100 days.

The hemp fiber is from the inner bark and is closely bound together by a resinous gum. the finest linens, lawns, cambrics and threads, as well as coarser materials.

Soils. The best soils for hemp are well drained, flat, alluvial bottoms. Good hemp can also be grown on rich uplands when special care is taken to make a deep, mellow seedbed and have the soil well supplied with moisture holding humus. Moisture is the essential factor in hemp culture, and it will endure an excess of moisture better than severe drouth.

Seeding. Hemp may be planted as early in spring as oats or rye, and south of Tennessee, at any time during the year. When grown for fiber it should be seeded broadcast at the rate of 3½ to 4 pecks per acre of plump, glossy 1-year-old seed and lightly harrowed in. It will not be necessary to weed the field, as is done with flax, since the rapidly growing hemp soon rises above all weeds and smothers them out.

Fertilizing. In fertilizing hemp nitrogen is the element of greatest importance when the crop is grown for fiber, and can be best supplied by heavy applications of barnyard manure, or by growing leguminous crops like vetch, cowpeas, etc., alternately with the hemp crop. In the

South hemp and cowpeas are alternated with each other the same year. The hemp grows so rapidly that the peas may either precede or follow it. Boyce in his book on hemp states that a crop of cowpeas followed by rye or vetch, to be turned under in March, will keep a soil in good condition for hemp year after year when the ground is once properly prepared, and especially if the refuse of the hemp is returned to the land.

Cotton seed applied at the rate of 1000 pounds per acre the fall before is one of the very best fertilizers for hemp. The addition of 200 pounds of acid phosphate and 250 pounds of sulphate of ammonia, composted with cotton seed and barnyard manure, is also recommended for poorer soils. The use of expensive commercial fertilizers is not generally profitable with hemp.

Harvesting. Hemp is in the best condition for harvesting for fiber when in full blossom. It is cut with a mower, or better with a heavy self-rake reaper, which cuts the stalks close to the ground and lays them off in bunches of about an armful. It may also be cut by hand like corn. The bundles or stalks are allowed to lie on the ground till retted—or rotted—by the dew and rain, when it is shocked like corn or tied in bundles and stacked. Sometimes the bundles are left lying out for 3 or 4 days after cutting, then turned over and left 3 or 4 days longer, after which they are tied in bundles and set up first in small shocks, then stacked and left for a few weeks to cure and then retted. It is claimed that better fiber is secured by the latter method. The yield of fiber varies from 500 to 1500 pounds per acre. Each increase of a foot in height to the plant adds about 150 pounds of fiber per acre. An acre of hemp about 12 feet high will yield about 1500 pounds of fiber.

Hemp is also grown for seed. The seed is used as a bird and poultry food and for making oils to mix with paints and for soap making. For seed, hemp should be sowed in rows or in hills like corn and cultivated in the same manner. Only about 2 quarts of seed will be required per acre. When the male plants begin to blossom all are removed except one of the most vigorous, to every 3 or 4 feet of row. After these have shed their pollen and begun to turn yellow they should be removed.

The crop is harvested like corn. The stalks are stood up together to dry out partially, after which they should be put in the barn or shed having a tight floor and threshed out with a flail. The yield will vary from 10 to 30 bushels per acre. To prevent heating the seed should be stored in 2-bushel bags or kept in shallow bins with numerous compartments.

Until the outbreak of the World War the U.S. imported about 560 tons annually. The future of hemp seems quite uncertain. The acreage as well as the favored locations are constantly changing from year to year.

HOP (*Humulus lupulus*)

The hop is a native to Europe and Asia and extensively raised in England, continental Europe and Russia. U.S. production varies from 27 to 47 million pounds yearly, according to demand and price. Oregon, California and Washington are our chief producing States.

The hop is a perennial climbing vine with harsh foliage and rough stems, which climb from 15 to 20 feet high and twine from left to right with the sun. The male and female flowers occur on separate plants. The flower is a catkin and the fruit consists of its enlarged scales, which form a cone ½ to 2 inches long. The ovary and bases of the scales are covered with a yellowish, aromatic, resinous subtance known as lupulin. This is the essential principal of the hop and the element which gives the characteristic bitter taste to beer. Ninety-five per cent of the hops grown in the world is used in the production of beer.

According to the Washington Station the Yakima Valley is well adapted to hops. "It is usual in this country to grow about 1 male plant to each 100 female plants. The hop plant sends out numerous runners just below the surface of the ground. These are removed by pruning, are cut into pieces bearing 2 or more sets of buds and are used to establish new hills which are usually 7 feet apart and number, therefore, about 880 per acre. Practically the only commercial use of hops is in brewing. Hops impart a characteristic flavor to beer, ale and other malt beverages, from ½ to ⅘ of a pound of dry hops being used for each 31-gallon barrel of beer. At harvest the vines are lowered for picking and the cones are picked by hand and then dried and baled. Hop raising began in New England in 1629, later expanded in New York, and by 1859 reached California. At present the 3 Pacific States produce practically all the hops grown in the U.S."

Two pieces of root are planted in each hill. From a wooden stake driven into

the hill a string is stretched to the wire trellis above and the vines twine upward on these strings often growing 12 inches per 24 hours. Frequent and early cultivations are essential. One to 4 vines are trained around each vertical string, later trainings being required to attach the vines to the horizontal wires in the trellis above. Pruning is another necessary operation and consists in cutting away excess roots from the main rootstock.

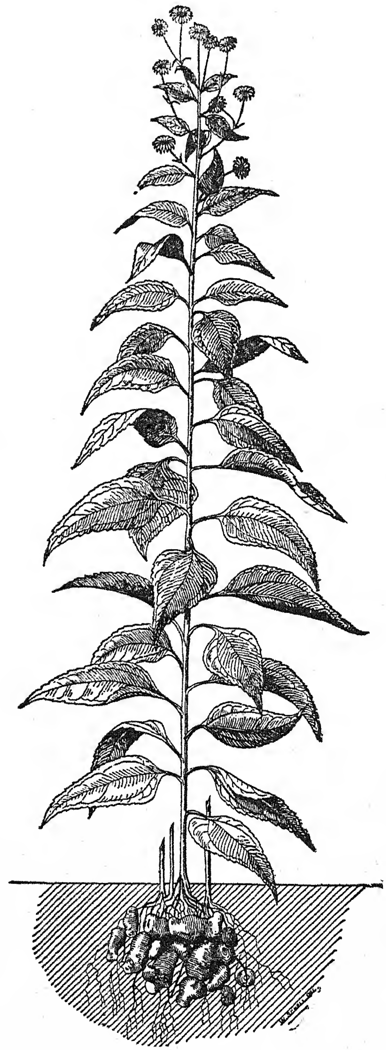
The exact stage of maturity for picking can be learned only by experience. On large hop acreages it may be impossible to pick all the hops at the proper stage of ripeness. Limited capacity of the drying kilns may also make it necessary to pick some of the hops somewhat green. Delay in drying may cause the hops to heat with resultant injury to their quality. Clean picking is a vital matter. Leaves or stems lower the value of the product. Recently mechanical hop-pickers are coming into use and are giving satisfactory service. Water makes up about 65 to 75 per cent of the hops when picked, whereas after drying they should contain only 10 to 15 per cent moisture. Drying is a ticklish part of the technique of hop culture. This art depends almost wholly on experience and, as in many other agricultural operations, is handed down orally and by demonstration from one generation to another of hop growers. U.S. grows about 27 per cent of the world hop crop, and our exports of hops are usually larger than our imports. The acre yield of dried hops in U.S. is about 1450 pounds as an average.

An average hop farm in the Yakima Valley, with a total size of 49 acres, of which 40 acres are irrigated, is divided among several uses as follows:—14 acres hop, 11 acres alfalfa, 3 acres irrigated pasture, other irrigated land 12 acres, while the total capital investment runs from $7,000 to $50,000 per farm. Satisfactory financial success with hops seems to depend on control of diseases and insects, proper soil treatment, skill in irrigation and correct methods of drying the hops.

Perhaps the most serious hop disease is mildew which may be held in check by spraying with Bordeaux mixture or dusting with sulphur. The hop grub is the larva of a yellowish moth about 1½ inches across the wings. During June the larva feeds on the plant just below the surface of the soil. Wood ashes or ammoniated phosphate added to the soil before hilling up helps to prevent injury from the pest.

JERUSALEM ARTICHOKE (*Helianthus tuberosus*)

A yellow flowered perennial plant, growing from 8 to 10 feet high, and much resembling in appearance the wild sunflower. The plant is grown almost exclusively for the underground potato-like tubers which it produces. There are white, yellow, red and purple varieties, but the white and red Brazilian varieties have generally given the best yields. The tubers, although sometimes used as a vegetable, are now grown in this country principally for stock food particularly for hogs.



PLANT AND TUBERS OF JERUSALEM ARTICHOKE

The Jerusalem artichoke will grow on almost any well-drained soil. It will thrive and produce abundantly on light sandy or gravelly soils too poor for many other crops. The main requirement seems to be a dry soil. If the soil is wet the tubers rot. The plant is drouth resistant, and as a rule remarkably free from fungus diseases and insect pests.

The plant is propagated like the potato by means of tubers. Whole tubers or sets are used for seed, and the hills should be spaced 3 feet apart each way. The plant is not as sensitive to frost as the potato, and may therefore be planted much earlier in the spring, or as soon as the ground will permit. Cultivation throughout the season should be about the same as that given potatoes, though it will do very well with much less attention. The crop matures in about 5 months. The tubers may be harvested like potatoes, or left in the ground over winter without harm. If grown for hog feed, they may be left in the ground and the hogs allowed to root them out. Tubers remaining over winter under the soil will as a rule grow the next spring. By this means the soil may be kept stocked, but it is usually advisable to replant each spring, or at least every 2 years. The yield is usually greater than that of potatoes, varying from 275 to 1000 bushels per acre. The tuber has about the same food value as potatoes, and is superior to turnip and mangel-wurzels for feeding purposes. Some trouble is occasionally experienced in inducing the hogs to eat the tubers raw, but they soon acquire a taste for them and thrive on them. They are especially recommended for range hogs by the Arkansas Station. One acre of artichokes will keep 20 to 30 hogs from October to the following June in good condition.

It is not expected that Jerusalem artichokes will generally take a very prominent place in ordinary farm operations in the U.S., but as a side crop, which will furnish a large amount of stock food, with a little care and cultivation, on soils too poor for many other crops, it certainly deserves the serious consideration of farmers, especially those raising hogs to any great extent.

KUDSU

This is a rank leguminous vine with large, deep, starchy roots and often attaining a length of 50 feet in a single season's growth, was introduced from Japan about 50 years ago. Like velvet bean, it was first used as a shade on trellises and buildings. Today Kudsu finds its chief service in checking erosion in the soil conservation work in the South East. This account is based largely on the observations of R. Y. Bailey and others of the Soil Conservation Service. Kudsu thrives except on sandy and shallow soils from Florida to Maryland, but is most at home in the lower and middle south. Eroded and gullied fields are a conspicuous feature of southern farms where long cultivation of row crops has permitted the excess water from heavy showers to carry away the surface soils and excavate ugly gullies of all depths up to 25 feet or more. How to prevent these farms from being carried away into the Gulf while still cropping them was a poser of a problem.

Kudsu is one of the answers. For new plantings of this crop crowns from old fields are used. As many as 15,000 crowns may be dug from an acre of well established Kudsu. The use of Kudsu seed is less satisfactory. December to April is the usual range of planting dates and the spacing at first was such as to give about 1000 plants per acre. Later experiments indicated a wider spacing, 500 plants per acre, in rows 12 to 18 feet apart. Cuttings 5 to 6 feet long from 2-year old vines give good results when planted in furrows end to end and covered lightly.

Kudsu, while preventing the farm from running off to sea in the rain water, may also be used for hay. It may be cut late in the fall of the second season, or sometimes, it is better to wait till the third or fourth year. At the Alabama Station a special attachment to the cutter bar of the mower has been devised which largely overcomes the difficulty presented by the tangled growth of Kudsu. The yield of hay is fair and the quality and feeding value good if cut from early summer till fall or before frost. Too frequent cutting exhausts the starch supply in the roots and delays recovery and subsequent growth. As a pasture crop also Kudsu is highly valuable, providing grazing for dry periods. The usually rapid and rank growth of the crop, however, does not mean that it is inexhaustible. Like all pasture plants it can be abused and all but destroyed by overgrazing. It will not stand being eaten off to the ground.

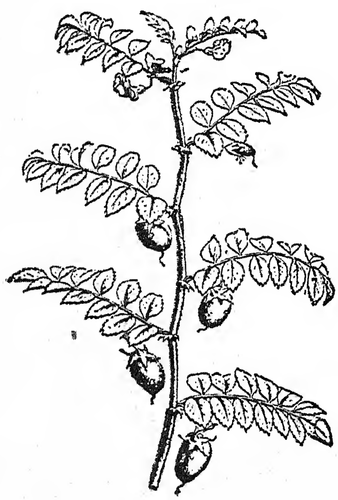
MISCELLANEOUS LEGUMES

Those legumes that have acquired large importance as field crops in the U.S. have been discussed in alphabetical order under their common names. There remain for

consideration several leguminous plants of lesser economic significance but which have gained a foothold on farms here and there and may achieve a wider popularity as new uses are found for them.

Berseem (*Trifolium alexandrinum*) is the key crop of Egyptian agriculture along both banks of the Nile from Sudan to the Mediterranean. This is the clover of Egypt. From the poorest fellah to the richest sheik berseem is considered a necessary crop to rotate with corn and cotton. It is an annual resembling crimson clover but with white flowers, shorter heads and narrower leaves. Several varieties are known in Egypt. In the U.S. it has been tested in various localities but it has not been shown to possess any special advantage over our established legumes under American conditions. In fact in South Dakota, Delaware, Kentucky and elsewhere it winter-killed too easily, or for other reasons failed to thrive. Possibly berseem will be found suited to culture in milder southern and western states especially under irrigation.

Chick pea (*Cicer arietenum*) is an annual with vetch-like leaves divided into 7 leaflets. It reaches a height of 12 to 18 inches and seems better adapted to culture in arid or semiarid regions than in humid ones. It is quite sensitive to frost. Chick pea is also known as gram, and is



CHICK-PEA

the familiar garbanzo of Mexico and other Spanish-speaking countries. In India and other parts of the Orient it has long been grown as food for man and beast, and often for adulterating coffee. The pods are from ½ to ¾ inch long and contains 1 or 2 wrinkled peas somewhat larger than garden peas. While adapted to nearly all soils chick pea prefers loams or clays. In Colorado when planted in rows 30 inches apart and 6 to 12 inches distant in the row, it made excellent growth when a plenty of water was given, and did fairly well under dry-farming conditions. From 30 to 50 pounds of seed per acre was sown and the average yield was 10 bushels. In chemical composition chick pea is similar to field pea. The forage is said to be dileterious to horses by reason of the oxalic acid in the leaves. The small growth of the plant renders it of little value for green manuring in comparison with other more luxuriant legumes. It matures in about 90 days. As human food it is highly prized by those who have become familiar with it.

Sarawak bean (*Dolichos hosei*) is a trailing legume introduced from Borneo, covering the ground like velvet bean. It bears dark green trifoliate leaves and small yellow flowers. This bean will survive only in relative frost free areas. In Florida it grows either in dense shade or sunlight. Under some conditions it may prove satisfactory as a binder for eroded banks or as a cover crop in orchards.

Hop clover (*Trifolium dubium* and *procumbens*) are low winter annuals resembling lespedeza in habit of growth. In Mississippi these clovers are used mostly in pasture mixtures and are sown after the grasses in the mixture have become established, 3 to 5 pounds of seed per acre being about the right rate. Under favorable conditions hop clovers may excell White Dutch clover.

White Dutch clover is a form of *Trifolium repens* and is reported as being the best spring clover for Mississippi pastures. It covers a longer grazing period than any other clover, seeds profusely throughout the season, lies dormant during dry weather and revives as soon as rain comes. It is adapted to all kinds of soils and has produced up to 10 tons green material per acre.

Persian clover (*Trifolium respinatum*) is an annual with about the same soil requirements as white clover. In Georgia it thrives well on rich, moist bottom lands, preferring the coastal plain to the northern Piedmont on account of the milder winters in the former area. While it seems happy in a mixture with pasture grasses, it shows no outstanding qualities that would make it preferable to white clover.

Subterranian clover is so named because of its seeding habits which resemble those of the peanut. The Georgia Experiment Station has studied the plant. The flowers bend toward the ground and the seed becomes buried in the soil if it is not too hard. "When not grazed too closely and on rich soils the mat of runners may be 4 to 6 inches deep, and along with the solid mass of leaves on top forms a vegetative cover that excludes all possibility of soil erosion." By the same token weeds are exterminated. The plant has persisted in one pasture for 11 years despite almost continuous grazing by sheep.

Bur clover (*Medicago arabica*) is obtainable only in the bur which, according to experience in Georgia, should be sown at the rate of 1 to 3 bushels per acre. Growth of this plant is favored by a high lime content of the soil. Bur clover is already used extensively in the south for temporary grazing and as a winter cover and green manure crop.

Black medic (*Medicago lupulina*) is a winter annual legume like bur clover but superior to it for pasture because it reseeds more profusely and is more palatable as found in trials in Mississippi. The plant is erratic in its behavior and is recommended only for soils high in lime.

Flat pea (*Lathyrus sylvestris*). A leguminous forage plant much resembling in appearance the common Sweet or Everlasting pea. Where it succeeds it forms a rank tangled mass of vines 3 to 4 feet high and yields heavy crops. In favorable localities several cuttings are obtained each season, and a field once established will endure for years. The pea is hardy as far north as Canada.

The serious objection to it as a forage crop is that stock do not relish it. Both cattle and sheep lost flesh on rations of either flat pea hay or flat pea silage at the Michigan Station. It is very rich in protein, the air-dried hay analyzing about 27 per cent of protein.

The special value of the plant appears to be its ability to grow on light soils too poor or dry for clover or corn. An objection to it is that it requires 2 or 3 years to get it established. The seed may be planted in spring either in drills 18 inches apart in place or in a seed bed, and the seedlings transplanted in the spring of the second year. In light dry soils the seed should be put in 2 or 3 inches deep, but shallower in heavier soils. During the first season the plants grow 8 to 12 inches, and should be kept free from weeds. The plants do not attain full vigor until the third season. The vines grow in such a tangled mass that they have to be cut with a scythe or sickle. The plant is perennial in the Gulf States, but is killed down each winter in the north.

The crop appears to be an excellent soil renovator. It may be found valuable where better forage crops cannot be grown, but experiments up to the present indicate that for forage purposes it is unsatisfactory.

Lentil (*Lens esculenta*). An annual leguminous plant much grown in Europe for its round flat seeds, which are boiled for soup or cooked like beans. The plant is little grown in this country. It requires a warm, sandy soil, and should be planted at about the time soup beans are. Sow in drills 18 to 24 inches apart and harvest when the stems begin to yellow. The seed may be beaten out with a flail after the pods are dry.

Serradella (*Ornithopus sativus*). A slender leguminous annual, 12 to 18 inches high, slightly resembling vetch. It is considerably grown in Europe as a green manure crop for dry, sandy soils, and to some extent for hay. It has been grown at a number of stations more or less successfully. In Massachusetts it yielded at the rate of 2 tons per acre. At the Oregon Station it grew 40 inches high. Results obtained in feeding green serradella have been very satisfactory. In general it may be stated that where well-known forage crops can be successfully grown serradella has no place. Serradella may be seeded in the spring with any of the small cereals the same as clover. When seeded alone it is best drilled in rows about 5 inches apart in March or April at the rate of 40 to 50 pounds of seed per acre. The seed matures in September.

Sainfoin (*Onobrychis sativa*). Also called Esparcet. A deep rooting, perennial, leguminous forage plant, 1 to 2 feet high, especially adapted for culture on ground too dry and barren for red clover or alfalfa. It has long been grown in Europe, but is little known here. The leaves are compound and composed of 6 to 12 pairs of leaflets, flowers bright pink in spike-like racemes. In Europe the yield of hay is from 1½ to 2½ tons per acre and is fully equal in feeding value to red clover.

Plant the seed any time from May 15 to June 30 in well-prepared land that is well underdrained. It is one of the best plants for barren hills. Cover a little deeper than alfalfa or clover seed. The

plants are a little difficult to establish, but when well rooted will endure for years. About 80 pounds of fresh seed should be sown per acre. If this is shelled 40 pounds will be enough. One crop of hay may be cut annually. The yield of seed varies from 10 to 25 bushels of 40 pounds each annually. It will not stand close pasturing. The plant will grow anywhere in the United States, and its use on poor soils where clover will not grow is recommended.

Sand lucern (*Medicago media*). This is so similar in appearance to alfalfa that it is difficult for the ordinary observer to distinguish them apart. It is a leguminous perennial forage plant and compares in feeding value favorably with alfalfa. Sand lucern is a more spreading plant than alfalfa. The flowers vary in color from bluish to lemon yellow. The seed pods are in a ¾ coil rather than 2 coils, as is the case with alfalfa. It has been but little grown in the United States, but some recent experiments at the Michigan Station indicate that it has considerable value on light, sandy soils in situations where alfalfa winter-kills. Owing to the high price of sand lucern seed, time required to establish the field etc. it is recommended by that station only for permanent meadows. The crop was seeded at that station May 15 at the rate of 20 pounds per acre. The lightest sand soil on the farm was used. The following year it yielded at the rate of 6800 pounds cured hay per acre in 3 cuttings, the third year 10,580 pounds, fourth year 12,310 pounds, and fifth year 13,839 pounds in 4 cuttings, no manure being used in the meantime. All stock relished the hay and green forage. These figures show a high yield of forage for sand lucern.

Seed broadcast on well prepared and finely pulverized soil at the rate of about 15 pounds per acre. Seed without a nurse crop. Keep the weeds in check by running over the field as often as necessary with a mower with the bar set high. Harvest as soon as the first blossoms appear. Seed at present is obtained from Europe and can be obtained through any reliable seed firm. Not enough experiments have been reported in this country to determine the value of sand lucern as a forage plant. It appears to be well suited to sandy soils, and to withstand open winters better than alfalfa.

This plant has been considered a hybrid between alfalfa and another related species.

Sulla (*Hedysarum coronarium*). A perennial legume, used for forage. Native of southern Italy. It has been grown to a very limited extent in a few places in this country. It is not injured by a slight frost, but freezing the roots kills it. It requires well-drained land for its best growth. In the Gulf States, where it has given the most promise, it is seeded in September or October on well-prepared ground either alone or with winter oats or wheat. The crop comes on the following summer after the grain is removed. It is said to grow from 4 to 8 feet high and to be equal in feeding value of alfalfa.

Crown Vetch (*Coronilla varia*), a trailing legume with abruptly pinnate leaves without tendrils, introduced from Europe. The vines reach 2 to 3 feet in length, making a densely matted growth. The blossoms are pink and white in rounded terminal heads. The plant is a brilliant ornamental as well as useful for holding weeds in control and checking soil erosion. It grows even on poor soil without nodule inoculation, but is still of very limited distribution in the U.S.

Birdsfoot Trefoil (*Lotus corniculatus*), an herbaceous perennial legume 12 to 30 inches high with slender, branching stems, long used as a forage plant in Europe, has recently become established in eastern New York and western Oregon. Tests show that this, and a closely related species, are adapted for use as pasture and hay. It seems to thrive on poor soils in the Catskills and on the more fertile soils of the Pacific northwest. The plant is a recognized element of the permanent pasture mixtures of New Zealand and Australia, and the farmers who have tried it in U.S. praise its feeding value in pasture and for hay. The Department of Agriculture reports its use in mixtures containing red and alsike clovers, orchard grass, timothy and rye grass. For hay the crop may be cut and handled like alfalfa or clover. It is a long-lived plant. In parts of Oregon even after being grazed and cut for hay for 20 years, the trefoil still shows a good stand without apparent deterioration.

Lupines (*Lupinus* spp.). These plants belong to the pea family. There are about 100 species, mostly annuals and herbaceous perennials. A few have been brought under cultivation as forage crops, but primarily for green manuring. A large number are also grown in gardens for their terminal racemes of bright colored flowers. About 70 species are native to western North America, a few to east-

ern North America and to the Mediterranean region. Lupines are not cultivated to any extent in the United States; but in Montana, Idaho and some other Western States the species *L. leucophyllus, L. sericeus* and *L. pseudoparviflorus* grow wild in such abundance that they are cut in enormus quantities for hay. The plant contains an alkaloid that sometimes poisons stock. The alkaloid is most abundant in the ripe seed. The green crop may be pastured throughout the season; but it should not be cut for hay until after the pods have burst open and the seeds fallen out. This takes place the latter part of August. Sheep are more susceptible to lupine poisoning than horses or cattle. *(See Poisonous Plants)*

In Europe lupines are cultivated to some extent for forage, but mostly for green manure. The yellow lupine (*L. luteus*) is most extensively used for this purpose, and to a lesser degree the blue lupine (*L. augustifolius*) and white lupine (*L. albus*).

The lupines are especially valuable as green manure crops on light sandy soils too poor to grow anything else. The yellow lupine is reported to grow even in sand dunes along the coast. They are not suited to calcareous soils or wet situations. Seeds of this variety should be sown in May or June in drills 9 to 15 inches apart at the rate of 1½ to 2 bushels per acre.

At the California Station spring sown lupines were a failure; but when fall sown heavy crops were obtained. Thus planted they were a valuable winter cover and green manure crop. On clay soils it was found that lupines would tolerate twice as much lime as on sandy soils. For strong calcareous soils the pink lupine (*L. pilosus roseus*) and large blue (*L. pilosus coeruleus*) are recommended. It is only for special situations that lupines will have any value for American farmers over other leguminous plants.

Beggar Weed (*Desmodium tortuosum*). An erect annual leguminous plant growing from 3 to 8 feet high and adapted for culture as a forage plant and soil renovator in the more southern States. As compared with alfalfa, velvet beans, soy beans and cowpeas, the Department of Agriculture says of it: "It is perhaps the best of these for the lighter sterile sandy soils, including the hammock and pine lands of Florida and the sandy pine lands along the Gulf coast." From 5 to 6 pounds of clean seed is sown per acre. If grown for hay from 8 to 10 pounds should be used. The seed is sown when the ground is warm and moist. The seed need not be covered if sown at the beginning of the summer rains. If seeded early 2 crops may be secured the first season. It should be cut for hay at the time the first flowers appear. The yield is from 3 to 5 tons of cured hay per acre, which is but slightly inferior to red clover in feeding value. It

FLORIDA BEGGAR WEED

is an excellent crop to turn under for green manure, and is considered superior for this purpose to velvet beans when sown in orchards. It may be sown in the corn field at the last cultivation and will furnish good pasturage for the rest of the season. It does not become a weed. At the Florida and Louisiana Stations it has given good results. Cows and sheep are said to be very fond of it.

LESPEDEZA

About 125 species of lespedeza are known, all native to eastern Asia or eastern U.S., 20 perennial species belonging to North America. Of this group only three are of much economic importance, the perennial *L. sericia* and the 2 annual forms: common and Korean lespedeza. Common lespedeza was brought into the

U.S. about 100 years ago, Korean in 1900 and the perennial in 1896. As described by Pieters, common lespedeza is a slender plant that is mostly prostrate unless grown in dense stands, with both purple and inconspicuous flowers, small leaflets somewhat like those of alfalfa, and reaching a height of 15 to 24 inches. The Korean is larger, coarser, earlier in maturing and with stem hairs pointing upward. The lespedeza belt of the U.S. may be right depth if drilled. If broadcast or spread with a cyclone seeder the seed may be left on the surface, or if sown on an established pasture, light treatment with a spike toothed harrow may help. Seeding is done in early spring from February in the south up to April in the north. One of the methods of utilizing lespedeza in Kansas consists in broadcasting it in oats or other grain in early spring. It then germinates in April and is ready to

KOREAN LESPEDEZA WITH OATS

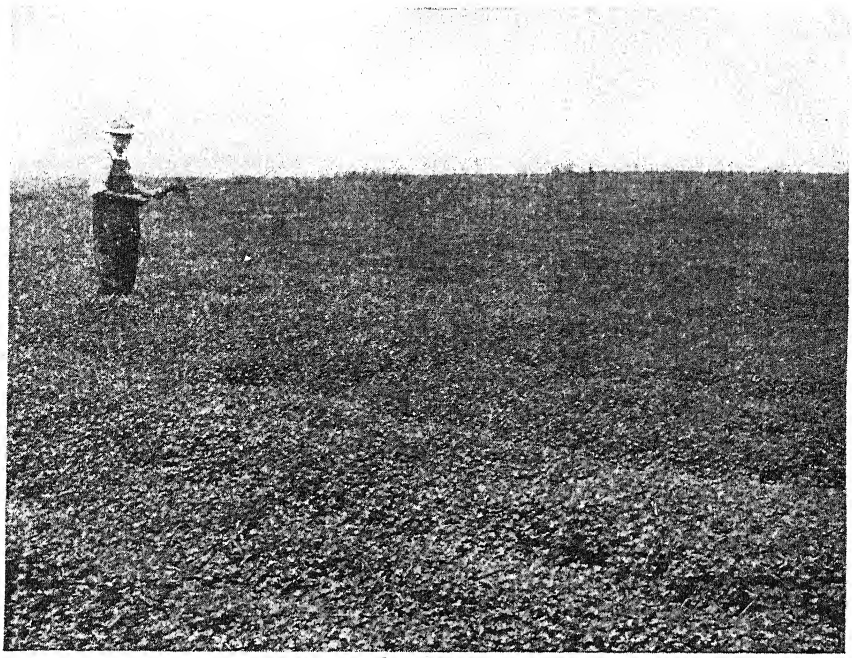
said to extend from the Potomac and Ohio Rivers to the Gulf and westward through the eastern third of Kansas. Rainfall is the limiting factor in the west. Lespedeza is a warm weather crop. Spring growth is slow and the crop will not bloom and seed if the days are too long, excessive sunshine having a depressing effect on seed development.

Estimates of the acreage of the lespedezas are rather vague, perhaps 4 million acres raised for hay, 800,000 acres for seed, besides other millions of acres of volunteer growth in grazing land. The seed requirements usually recommended are 25 to 30 pounds per acre for Korean and common lespedezas and slightly less for the perennial form. The seed may be sown alone, or on grain, or in corn at the last cultivation. A half inch is about the be grazed soon after the grain is harvested. The lespedeza matures seed in the fall and volunteers the next spring so that the rotation may be continued without reseeding with lespedeza.

Perhaps the use to which lespedeza is especially suited is for checking erosion of abandoned lands, gully walls and roadsides. It is easy to secure a stand of these plants in the poorest soils even without preparation of the seed bed, and even the thinnest stands help to slow down the run off of surface water and to prevent further soil erosion. When sown with spring grain and pastured till frost the stubble serves as protection against erosion during the winter. In the apple region of northeastern Kansas lespedeza plays an important part as a cover crop in orchards. Apple growers plant it as a

permanent crop on sloping orchard lands where the plant continues to volunteer year after year. With its rather shallow root system it competes for water and plant food in the soil less than do sweet clover, alfalfa or perennial grasses. Moreover the small top growth interferes less with the regular orchard operations.

Perennial, or sericea lespedeza, resembles alfalfa in habit of growth. After becoming established more shoots come from the crown so that by the fourth year there may be 20 to 30 stems per plant or even more. This species becomes very woody if cut for hay too late in the season and such stems are of no value for feeding. A rather high content of tannin, 3 to 4 per cent, is found in all lespedezas. This furnishes another good reason for cutting the crop for hay before full maturity. Analyses show that the tannin content of the leaves may double during the month of June while at the same time the protein content is diminishing. The lespedezas are not much worried by weeds but seem to stand their ground in competition with them except in the case of dodder.



KOREAN LESPEDEZA IN TENNESSEE

MILLET

Millet is a general term used to cover several kinds of cultivated grasses grown for their seed or forage value.

Foxtail Millet (*Setaria italica*) has been recently made the subject of a thorough study in Colorado by J. J. Curtis and others of the Bureau of Plant Industry. This millet has been raised in China since the dawn of history but has never found a large place in farming operations in the U.S. except in Colorado. It is a leafy erect annual with seeds borne in dense drooping panicles. It matures rapidly requiring only 75 to 90 days for seed and a shorter period for forage. It has been used as a catch crop where winter wheat or other small grains have failed, since it will mature if sowed as late as July 1. Highest yields have been obtained when sown on fallow ground. Corn or sorghum do better than small grains when following foxtail millet.

Soil and Seeding. Millet requires warm weather for its successful growth. Frost kills it about as easily as Indian corn. The best soil for millet is a rich, well drained sandy loam. On heavy clays

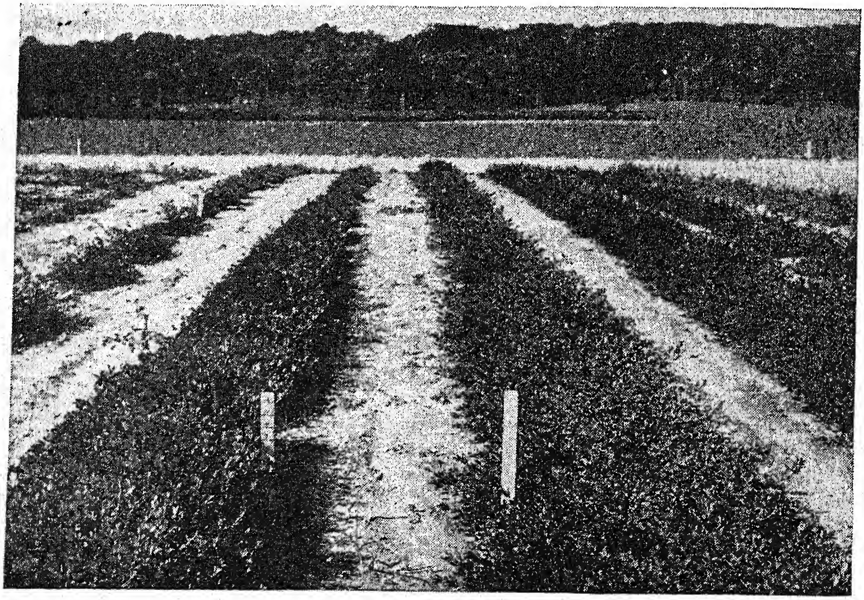
or wet lands it will not thrive. Millet is hard on the land, not because it withdraws more plant food from the soil than many other crops, but because of its shallow feeding root system it draws most of its plant food from near the surface of the soil.

Millet is usually seeded after corn is planted, the last of May or first of June. In the South it may be sown as late as August. The seedbed should be well plowed and harrowed and free from clods. When grown for hay about ½ bushel per acre of Hungarian grass, German or common millet is required. The broom corn millets require about ¾ bushel per acre. For seed only about half of these quantities need be sown. The seed may be either drilled in or broadcast and lightly harrowed in. For soiling purpose the crop will be ready for use in about 60 days.

Harvesting. Millet should be cut for hay between the time of complete heading out and late bloom. Cutting should never be delayed until the seed begins to ripen, owing to possible injurious effects it may have on the animals eating it, particularly horses. There is no danger whatever in feeding the green or ensiled forage or hay made before the seed matures. For soiling and silage it may be cut a little later than for hay. After cutting for hay the millet should be allowed to wilt for a few hours, then tedded once or twice, after which it should be put into small cocks and allowed to cure 2 or 3 days before hauling to the barn or stacking. Millet stems are large and succulent. The crop is cut greener than most hays and requires more drying, principally in the cock, than other hays. Otherwise it is no more difficult to cure than clover and will endure much more exposure to rain and dew without serious injury. The hay is sometimes cut with a self-binder and the loosely tied bundles cured by setting up two and two in long shocks running north and south, and thus exposed to the full sunshine. This is an easy way of handling the crop. The yield of cured hay varies from 1½ to 3½ tons per acre.

Millet for seed is harvested like any small grain crop. One of the best methods is to cut with a self-binder when the seed is in the late dough stage and stand the bundles two and two in long shocks. When dry enough thresh from the shock. The yield averages about 20 to 25 bushels per acre and varies from 5 to 75 bushels per acre. A bushel varies in weight from 45 to 50 pounds.

The preferred varieties of foxtail millet are Siberian, Goldmine, Hungarian and White Wonder. This millet is an important hay crop for irrigated lands in eastern Colorado. The seed when ground has a feeding value about 80 per cent that



LESPEDEZA TESTS IN TENNESSEE

of corn. Best results for hay have followed seeding after a rain between May 15 and July 1.

Proso (*Panicum miliaceum*) also known as hog millet or broom-corn millet, is best suited to the northern prairies or Great Plains, particularly Minnesota, the Dakotas, Montana, Wyoming, Kansas and Nebraska. Proso is sensitive to frost, is not suited to most systems of rotation, and the yield is not high enough to qualify it for a main crop, but rather as a late catch crop for grain. It is commonly seeded at the rate of 1 to 3 pecks per acre and average yields run from 10 to 30 bushels per acre, although under specially favorable conditions much larger returns have been secured. In feeding experiments with pigs in North Dakota Proso proved inferior to corn or barley.

Pearl Millet (*Pennisetum spicatum*) was introduced into the United States about 100 years ago and has been cultivated to a limited extent ever since then, more particularly in the Southern States. The plant is an erect succulent grass 6 to 15 feet high, with very leafy stems terminating in a cylindrical spike, 6 to 14 inches long. It is grown as a soiling crop and for hay and next to teosinte is perhaps the heaviest yielding forage plant cultivated in the U.S. Pearl millet revels in rich, warm alluvial soils; but can be grown on most corn lands. It is easily killed by frost and should therefore not be planted until the season for corn planting. The ground should be well prepared and again cultivated just before seeding to destroy weeds. If grown for soiling, sow in rows 3 feet apart and 6 inches apart in the row, for hay seed in rows 18 inches apart and about 4 inches apart in the row. With good seed about 4 pounds per acre will be required for the thinner planting and 8 to 10 pounds for the thicker planting. When the crop is broadcast for hay about a half bushel of seed should be sown. The seed should be covered only about ½ inch deep. Shallow, level cultivation as for corn should be practiced. At 11 experiment stations where pearl millet has been grown the yield has varied from 5 to 40 tons of green forage per acre, and from 1½ to 16.4 tons of hay. The number of cuttings varies from 1 or 2 in the Northern States to 3 to 5 in the Southern States. The chief value of pearl millet is as a soiling crop. For this purpose cutting should commence when the crop is 3 to 4 feet high. It starts more readily into a second growth if cut 4 to 5 inches high. For hay it should be cut just as the heads are appearing. The green plant contains 75 to 80 per cent of water and is therefore difficult to cure into hay. It is handled in the same way as corn fodder. The stalks are cut either by hand or machinery and bound into small bundles and shocked. The plant appears very palatable to stock. While it yields perhaps heavier than the sorghums it is not likely to prove more satisfactory on most farms and will seldom prove as desirable or as valuable as corn.

OATS (*Avena sativa*)

Oats rank third, both in acreage and number of bushels, of the cereal grains grown in the U.S. Its native home was probably Asia. It was known to the Greeks who called it bromos from which the name of the western brome grass is also taken. The principal oat producing areas of the U.S. are in the corn and spring wheat belts where the climate is cool and moist. An important tongue of oat culture extends into the Southern Plains from Missouri to Texas. It is the hardiest of the cultivated cereals and is grown to some extent in every State and northward into Canada and Alaska. Since 1921, when the oat acreage reached a high of over 45 million acres, there has been a slow decline to about 32 million acres. Iowa, Minnesota and Illinois are the 3 leading oat States.

Oats have been grown in the northeastern States since early colonial days, being the third most important cereal crop in New York and Pennsylvania. Clay and loam are better than sandy soils. The crop is usually not highly profitable in cash returns, but fits in so well with routine farm rotations, and is such an excellent feed for horses, dairy cows and poultry, that it has retained an important place in the agriculture of this region for over 2 centuries. Oats are weak stemmed and lodge easily. For that reason they should not be planted on too fertile soils. Moreover, unless the soil is very poor, it may be better to apply commercial fertilizer or barnyard manure to corn, potatoes or some other crop in the rotation rather than directly to the oat crop. But on soils deficient in plant food a complete fertilizer may be applied to the oats. Rotations with oats usually include a hoed crop and a legume. Corn stubble land sowed to oats the following spring makes a good preparation for returning to clover and timothy the third year of the rotation since oats are a satis-

factory nurse crop for those standard meadow plants. This actually makes a 4 year rotation since the grass and clover are retained for 2 years. Or the series may be corn, oats, winter wheat and meadow.

Oats are often sown in combination with other crops, the oat-pea mixture being a familiar one in which 1 bushel of oats and 1½ bushels of peas are sown per acre. Barley and oats and oats and rape also make excellent combinations. In the latter case the rape remains as pasture for hogs and sheep after the oats are harvested. Occasionally oats are sown in a mixture with alfalfa. Peas and oats or oats alone may serve too as winter cover crops for orchards.

For seed bed preparation in the eastern States, fall plowing is preferable, or in early spring if that is not feasible. "The best seed bed for oats consists of from 2 to 3 inches of mellow soil on the surface with a rather firm layer of soil beneath. Whenever serious losses by water erosion occur fall plowing is not advisable" according to T. R. Stanton of the Department of Agriculture.

Seed oats should be run through a fanning mill. This removes the light oats, trash and weed seeds which may make up ⅓ to ½ of the original material. The light oats would not germinate and the screenings may be fed to stock, so that no loss is incurred. Early seeding of oats is advisable, about April 15 in West Virginia, Maryland, New Jersey and New York, and as late as May 15 in parts of New England. The rate of seeding in these States is about 2½ bushels per acre, preferably by drilling but less often broadcast.

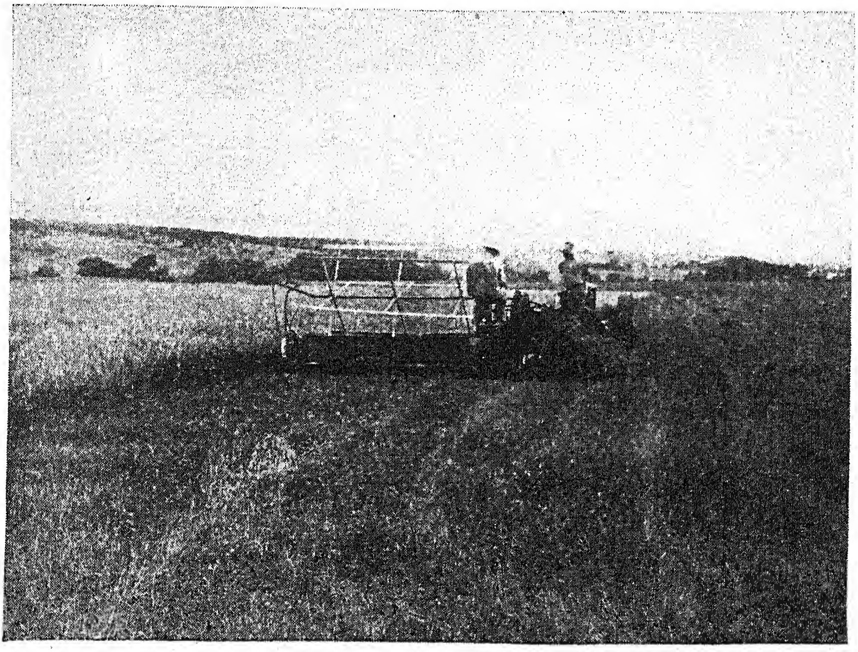
HARVESTING OATS IN MONTANA

Most oats in the northeastern States are cut with a grain binder, but on some rough hilly land the grain cradle is still used, harvesting being done when the grain is in the hard dough stage and the straw somewhat green.

Nearly 80 per cent of the U.S. oat crop is produced in the north central States. The climate immediately north of the corn belt is well suited to oats, particularly in Michigan, Wisconsin and Minnesota. Prairie loam soils produce high yields of oats. Fertilizers are of little use on oats in this section except in the eastern portion. The native fertility of black prairie soils, with their high nitro-

gen content, produced a rank, weak straw which lodged badly and was more susceptible to infection with rust. Barnyard manure may better be applied to a preceeding crop, such as beans, corn or potatoes. "The most common rotation in the corn belt consists of oats preceded by corn and followed by grass or clover. This rotation may span 5 years:—corn 2 years, oats 1 year, grass or clover 2 years. But more often it is a 4-year rotation, including 2 years of corn and 1 year each of oats and clover." About the only mixture used with oats in the corn belt is oats and barley. In this region oats is the chief nurse crop for grass and clover. The foliage is perhaps a bit too dense but this drawback is partly overcome by using early, short strawed varieties. In making a selection among the almost innumerable varieties of oats raised in the corn belt one may well rely on the advice of the County Agent or Experiment Station.

Methods of preparing the seed bed, and the seed for planting, are essentially the same as for the eastern States. Where smut prevails the seed should be treated to prevent this disease. A satisfactory remedy consists in spraying a mixture of 1 pint each of formaldehyde and water. This quart of spray material will be enough for 50 bushels of seed. Shovel the oats from one pile to another, wetting each shovelful with the spray. Keep the pile covered with a canvas for 5 hours. Or the seed may be put into gunny sacks and dipped into a tank containing 1 pint of formaldehyde in 40 gallons of water, after which the seed grain will need 2 hours for drying. The seed is sown in this region during the last half of March or early in April, at the rate of 8 to 12 pecks per acre. Drilling gives better results than broadcasting.



HARVESTING OATS IN TEXAS

Cutting is mostly done with a grain binder, but combines have been used on a few farms with success. The sheaves are set up for curing either in round or long shocks. If weather is favorable it is best to allow the grain to become thoroughly cured before threshing. Oat straw is always worth saving for feed since as roughage it is superior in feeding value to the straw of other cereal grains.

Farther west there are 3 fairly well defined oat regions. First the Great Plains (Dakotas, Nebraska, Oklahoma and Texas, and parts of Montana, Wyoming, Colorado and New Mexico) at altitudes varying from 1500 to 5000 feet and an average rainfall of less than 20 inches.

Drouth, hailstorms and hot winds may cause heavy losses in this region. But under irrigation higher yields are obtained in the Great Plains than in any other oat region. The Pacific area is a narrow coastal strip from Puget Sound to southern California. In the Puget Sound and Olympic Peninsula areas of Washington, a yield of over 100 bushels an acre are not rare.

In the dry land section of the Great Plains and Rocky Mountain area summer fallowing is widely practiced, the land lying fallow one year and cropped to wheat or oats the next. A 2-year rotation of corn and oats is quite popular in the central part of the Great Plains. In Colorado and Idaho, under irrigation, a common rotation system includes alfalfa 3 years, potatoes or sugar beets 2 years, a cereal wheat or oats for 2 years as a nurse crop for alfalfa. In the Great Plains the earliest possible date in the spring is considered best for seeding oats, and the same is true for western Oregon and Washington, but along the Pacific coast oats may be sown between October 15 and February 15. In the Great Plains oats are cut with the binder, header or combine. When short-strawed or lodged on account of drouth or wind injury, oats are sometimes cut with a mower, raked into windrows and cocked.

Quite a large acreage of oats is cut for hay, especially on the Pacific coast. For this use they are harvested in the soft dough stage. Sown for this purpose in combination with peas the rate of seeding is 10 to 12 pecks of a mixture of oats and peas in equal proportions. Hungarian vetch is also used in an oats-vetch mixture.

On the value of oat and pea mixture for forage the Cornell Station found that "ranking next to corn as a forage crop and a close second, comes oats and peas. In the 2 years in which we have been conducting experiments in the production of forage this combination has proved itself well worthy of a place on every farm where stock is kept. It is valuable either for pasture, for cutting as a soiling crop, or when allowed to mature it may be cured for hay, making a most valuable article. When planted in succession of about 2 weeks, the first planting being as early in the spring as conditions will permit, a succession of highly nutritious forage is produced which is greatly relished by stock. If a more general use was made of oats and peas for summer feeding it would greatly decrease the expense of the production of milk and the cost of maintaining cattle and economize land very materially. A highly nutritious forage would be obtained, rich in protein and furnishing nearly a balanced ration for milch cows. A large amount could be produced per acre, and it may be grown from early spring to late fall. A slight freeze does not affect it and it may be sown in the spring before frosts are over, and the late forage frequently remains in good condition till December. The oats and peas at this Station sown August 1 were in good condition for feeding until a severe freeze on the night of December 2 cut them down. For late forage, however, barley and peas are recommended instead of oats and peas. For sowing any time after July 1 substitute barley for oats. The reason for this is that in late summer barley makes more rapid growth, is less likely to attacks of rust and other fungus diseases than are oats."

Remedies for smuts, rusts and the insect enemies of oats are treated under wheat.

PASTURES

There were shepherds before there were farmers. For untold generations men have wandered about the earth guiding their flocks of sheep, goats and cattle from one grazing ground to another in search of grass. This mode of life can be observed today in the Moslem countries from Morocco to Iran. Until quite recent years sheep and cattle ranged almost without restraint from State to State, from valley to mountain pasture and back again throughout the public land States of the west and always in search of grass. Nature eternally strives to cover the bare spots of the earth with grass. This almost universal carpet of grass was spread before the eyes of man as the chief source of meat, wool, hides and numerous other human necessities. But it was too much taken for granted, like air and water. A mere casual study of the history of our natural grazing lands in the west brings to view the sorry spectacle of man's abuse and wanton destruction of that great heritage. At last there has come about a realization of the vital importance of pasture in any system of agriculture, and numerous studies are in progress to learn how to preserve this grass carpet, and how to improve the condition of both wild and tame pastures.

Probably no country can show us a better example of what may be done with pasture than New Zealand. No other

country has 90 per cent of its cultivated land in permanent pasture. Her farms appear to be lawns or golf courses dotted with sheep and dairy cows, 16,000,000 acres of pasture grazed by sheep and cows, 365 days a year. These pastures carpet level, low lands, hills and the steepest volcanic slopes. Much of this pasture is 60 years old and still in prime condition. All the farmer does to it is to sow every year 18 to 30 pounds per acre of a mixture of grass seed, containing rye grass, orchard grass, crested dog tail, meadow fescue, meadow foxtail, timothy and red, white and alsike clovers. Or on very poor soils the mixture may be Chewing's fescue, danthonia, Rhode Island bent grass and clovers. The pastures are kept stocked with sheep or dairy cows at the proper rate to keep the grasses down to 3 or 4 inches in height. The animals are thus constantly feeding on grass clippings, which have been found to produce more milk than could be obtained from any other method of farming the land. Since the 2 products desired are milk-fed Canterbury lambs and butter, this style of agriculture might be called an exploitation of maternity.

The grazing lands of the west possess a remarkable power of recovery from overstocking. The forage plants on these ranges are of great variety. They include grasses, other herbaceous plants often called weeds by stockmen, and shrubby species called browse. The grasses most often mentioned as valuable forage include bunch grass, grama grass, buffalo grass and a host of others. The early explorers who crossed the western country from 1800 to 1850 left many detailed records of the condition of the range in those days. A study of their interesting travel accounts, to one who is familiar with present range conditions, will show the striking similarity in the appearance of the range in former times and today. Greely in 1859 saw a herd of buffalo which he estimated to total a million. Such immense herds wrought the apparently complete destruction of range grasses during their migrations north. But the buffalo did not return by the same route or visit the range again till it had recovered. Thus the buffalo taught the range stockman the lesson of deferred or rotation grazing. The grass may be ruined unless allowed to reseed each year.

In Nevada most of the sheep graze in mountain pastures in summer, on the southern deserts in winter and on the intermediate areas in spring and fall, covering hundreds of miles in their annual migratory round, as did the Biblical shepherds. Since the Federal Government has assumed regulatory functions in the use of public grazing lands, methods of preventing range deterioration are under study in the range States in the hope of permanently maintaining the grass cover of this great area. In many States attention has been turned to supplementing the native range by cultivated pastures, particularly in irrigated regions. In Colorado mixtures of 2 to 5 grasses, yellow sweet clover and red, white, Dutch and alsike clovers gave excellent results for either hay or pasture Artificial reseeding of the range will be successful only under favorable conditions. Improved range management promises better returns. Kansas started experiments with bluestem pastures 25 years ago. The results show that if grazing is deferred till September 1 the carrying capacity is no greater than if grazed the season-long, since the grass had lost much of its nutritive value by September 1. But when grazing was deferred only to June 15, the deferred pasture had a decided advantage. Tame pastures in Kansas are now occupied by brome, timothy, blue grass, winter cereals, sweet clover, lespedeza, rape and other cultivated plants.

In all parts of the U.S. the value of permanent pastures is becoming recognized. Thus in Georgia it has been found that "improved pastures supply more feed nutrients per acre at lower costs than most cultivated crops and are the basis for any increased and permanent profitable livestock industry." That conclusion is founded on experiments with a wide variety of grasses and legumes. The Nebraska Station has devoted attention to the collection of the seed of 24 species of important native grasses for reseeding damaged pastures and meadows, and for regrassing land taken out of cultivation. On many areas the so-called hay method has been tested, consisting in spreading mature hay containing ripe seed of native grasses over a prepared seed bed and providing tillage to cover the seed and anchor the hay. This method seems to have definite advantages. At last pastures are treated as a vital part of successful permanent agriculture and not as a stepchild of the farm.

PEANUT (*Arachis hypogaea*)

The peanut, a trailing leguminous plant, native to the tropics, first introduced into the U.S. in colonial days, but not coming

into commercial importance till after the Civil War, attains a height of 1 to 2 feet, bears blossoms along the stems, and after the flowers fall, pushes the ovaries into the soil where the pods and seeds mature. Our peanut empire covers the southern part of the country from California to coastal Virginia, being an important crop in at least nine of these States.

Roasted and salted the peanut is familiar to every man, woman and child. It is relished by all creatures from elephants to mice, made popular by circuses and pushcart operators, greedily devoured by birds and squirrels and furnishes a staple article of diet for farm animals. The fame of the peanut has acquired an added lustre by association with the name of Dr. George Washington Carver of Tuskegee, who devoted a lifetime of study to its almost innumerable uses. Its chief climatic need is a season of 100 -140 days with frost. Inside that belt it will thrive on almost any soil suitable for corn. The U.S. peanut area is about 5,000,000 acres.

A sandy loam soil best suits the peanut. On too heavy soils the pods are unable to push their way into the ground to mature. Dark or red soils discolor the pods and lower their market value. Gray porous soils that are not too rich, are usually advised. Being a legume the peanut draws a part of its nitrogen requirement from the air. Phosphorous and potash are therefore the most essential fertilizer elements to apply. In Maryland, Virginia and elsewhere in the South where lime is lacking, this element should also be added. Soils excessively rich in humus produce vines rather than fruit and the quality of the nuts is inferior.

Land for peanuts requires early plowing and thorough cultivation. Planting may be done at corn-planting time or immediately after. The seed is sown either in hills or drills. The spacing depends on the variety grown and the richness of the soil. Careful selection of seed is highly important. It is not necessarily the biggest seed that give the largest yield. But many plant breeders have been giving attention to the production of strains of seed which will yield a higher average of fancy kernels than the common run of unselected seed. We may expect great improvement in this direction much as has occurred in scientific breeding of wheat, corn and other farm seeds. An adequate supply of good seed is a prime essential. The Alabama Cooperative Peanut Growers Association makes a practice of holding back large quantities of seed for its members.

The peanut is an important cash crop in all the southeastern states, being grown, harvested and sold to mills for processing into the various peanut products used in commerce. In 1940 Georgia alone pro-

STACKING PEANUTS

duced nearly 554 million pounds of peanuts. In that state the yield per acre in recent years has ranged from 710 to 835 pounds. Rows 30 inches apart with 6 inch spacing in the row will require 27 pounds of shelled seed for sowing an acre. On poor soils 4 inch spacing may give better results. Many growers prefer 24 inch rows for the Spanish variety. Peanuts may be planted with corn and velvet beans for hogging off, but are not much interplanted with cotton for the reason that they compete too actively with cotton for moisture, and both crops mature at about the same time.

At the Arkansas Station it was found by experiment that nuts planted in pods broken once in two gave as good a stand as shelled nuts. This indicates that much of the labor of shelling peanuts by hand may be saved. During the growing season peanuts must receive frequent shallow cultivation to keep weeds under control. Most of this early cultivation may be done with a weeder. The former method of ridging to cover the bloom of the plant has been found unnecessary. In fact much better yields are obtained by level culture. After the vines begin to bloom they must not be disturbed.

The crop should be harvested before the vines are killed by frost. The right stage for harvesting is shown by the yellowing of the leaves and darkened veins on the inside of the shells. If dug before that time the nuts are not fully developed, and if dug later some of the nuts may begin to sprout if rain should occur. In Georgia several methods of digging are employed. Peanuts are easily loosened from the soil by using a one-horse turning plow with the wing removed. This cuts off the tap root and loosens the plants so that they may be easily lifted from the ground. Potato diggers will also do the job quite satisfactorily.

The vines are then thrown into windrows and if cut in the morning are shocked in the afternoon in piles about 7 feet high, with a pole in the center to hold the pile upright. The vines should be placed with the pods inside the pile and should be kept off the ground by means of poles. The piles may be covered with hay or cornstalks to protect the crop from rain. To prevent heating and souring the piles should not be more than 3 to 4 feet in diameter.

If peanuts are grown for hogs the animals may be turned into the field at the time of the first frost.

Formerly peanut hay, or the vines after removal of the pods, was treated as waste. Although this material is inferior to clover, alfalfa, soy beans or cowpea hay, it is well worth using for stock forage. The picking machines used for removing the pods leave some dirt in the hay and if the material becomes moldy it is unfit for use.

Peanuts grown for the commercial market should be left in the stacks for a curing period of 3 to 6 weeks before picking from the vines. Picking takes place from October to December while the vines are dry and brittle. Hand picking, as done in the early days, is not practicable for the large scale grower. There are several makes of peanut picking machines. The chief requirement is the removal of all the marketable pods with the least possible breakage. The machine should pick about 250 bushels a day. Some of the machines have a bagging attachment discharging the pods directly into standard bags.

Among the many varieties raised in the South, Virginia Bunch, Virginia Runner and Jumbo supply the large pods, while the Spanish is used mainly for shelling and the production of peanut oil. From Dr. Carver's list of 150 ways in which peanuts may be used a few additional items may be mentioned. As has been pointed out by the Department of Agriculture, and various State Experiment Stations, every part of the plant and all by-products of the factory processing may be utilized for stock feeding and for other purposes. Peanut hay, inferior pods, hulls, press cake, meal from oil mills, germs, red skins and broken particles of meat resulting from the manufacture of peanut butter and confectionery—all find use as feed for stock.

In the principal peanut state of Georgia shelling plants and oil mills are located at convenient points in the producing areas. Large quantities of the nuts are crushed by a hydraulic process after which the oil is refined and used in various human foods. The press cake from the oil mills is ground to make peanut meal which has been found fully equal to the best grades of linseed, cotton or soy bean meals in feeding value for livestock. The meal has proved exceptionally efficient in milk production. Moreover the meal is rich in lysine, an amino acid essential to growth of animals. It contains also an abundance of the vitamin B complex. In a series of tests with poultry in North Carolina it was found that when 60 to 90 per cent of the animal protein in a laying mash

feed was replaced by peanut meal no reduction resulted in egg production or in the hatchability or livability of the chicks. The feed cost was thereby greatly lessened. In most localities the peanut may be attacked by 1 or 2 kinds of leaf spot which may be controlled by treatment with Bordeaux mixture. If leaf hoppers appear the plants are pretty well protected by dusting with finely pulverized sulphur at 2 week intervals.

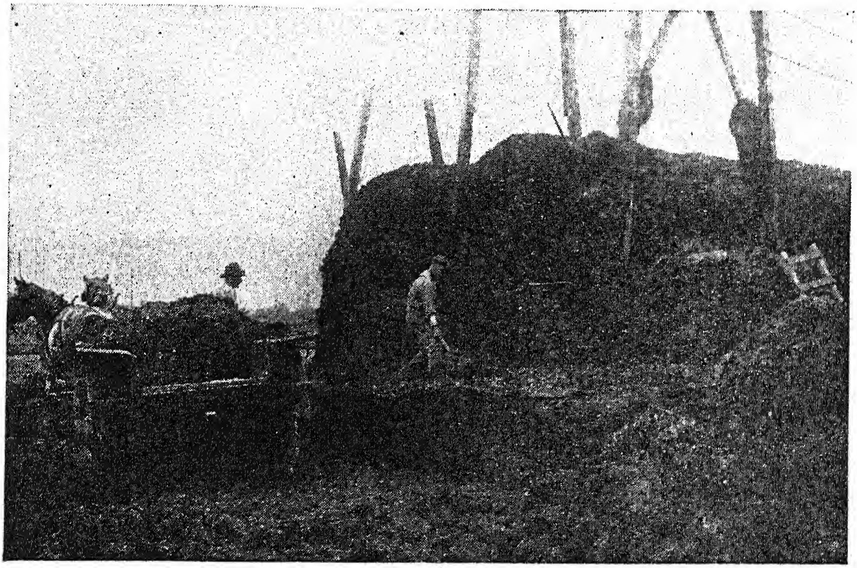
PEAS (*Pisum* spp.)

The common field pea did not attain much vogue in the United States, except as a home garden crop, until some time after it had come into wide use in Canada as a stock feed and as a fodder, soiling and soil improving crop. It is an annual plant with succulent stems 2 to 4 feet high which stand without support, but may lodge from excessively rapid growth or as the result of storms. The seeds are round, smooth and of various colors—yellow, green, brown or mottled. Peas are raised for forage or seed in New York, Michigan, Wisconsin, Minnesota, the Dakotas, Idaho, Montana, Colorado, Oregon and Washington, and as cover crop in the Cotton Belt and in the Pacific northwest. In the San Luis Valley, along the upper Rio Grande, at an elevation of 7500 to 8500 feet field peas are grown in patches of 40 to 320 acres as stock feed. As far back as 1914 about 260,000 sheep, 20,000 cattle and 15,000 hogs were fattened on peas in that valley. The prevailing San Luis method is a very cheap and simple one. The hogs run on alfalfa pasture till the peas are ripe in the fall. Then they go into the pea fields and stay there till ready for the packer.

In a study of irrigation requirements of peas in the Gallatin Valley, Montana, it appeared that seed and canning peas made the largest yield when irrigation was deferred till the plants were in bloom. Additional applications at 10 to 14 day intervals were needed to maintain rapid growth. The chemical composition of peas was noticeably affected by the time of applying water. In Louisiana, where the crop is called Austrian winter pea, the yield was greatly increased by using the nitrogen nodule inoculation.

Peas prefer a cool climate. High temperatures are much more disastrous than frosts. But they are grown as a winter crop from southern California to the Gulf coast of Texas. From Louisiana to Mary-

FIELD PEAS IN UTAH



PEAVINE SILAGE AT CANNING FACTORY

land peas are sown in the fall, from Wisconsin to Maine in the spring and in the intermountain and northwest in the spring with or without irrigation. Variety names of field peas are numerous and much confused, there being some 200 supposed strains in Canada alone.

Early seeding is best in the northern States, March or April according to weather conditions. In the south winter peas follow cotton so that little special preparation of the soil is necessary. September and October are good months for seeding in the northern half of the Cotton Belt. According to the size of the seed, and moisture conditions, the amount of seed per acre varies from 45 to 100 pounds. Best results are obtained when the land is fall plowed, though peas will do better on spring plowed lands than grain crops. Peas are grateful for a well prepared seed bed, but they are vigorous growers and will tolerate considerable neglect on that point. Drilling is preferable to broadcasting. The seed should be covered from 2 to 4 inches depending on the kind of soil.

Peas may occupy almost any place in a system of farm rotation, but usually some grain crop as wheat or oats should follow the peas to receive the benefit of the nitrogen left by the pea roots.

Field peas are harvested when the majority of the pods are matured and the leaves have begun to turn yellow. The crop is commonly cut for seed with an ordinary mowing machine with a bunching attachment. This method is found by the Department of Agriculture to leave the peas in better condition to be stacked or hauled to the thresher than when thrown into windrows. Three men and a machine should bunch about 10 acres a day. If the vines are stacked, a good top of marsh hay or canvas should be used to cover the stack as the vines lie loose and admit rain readily.

Threshing is mostly done with a common grain separator or combine especially fitted for the purpose, leaving only one row of concave teeth below the cylinder. By limiting the number of concave teeth, and reducing the speed of the cylinder, it is possible to avoid cracking any large percentage of the peas. The commercial production of field peas is largely centered in Washington, Oregon and Idaho where conditions seem to be particularly favorable. This has become an important industry and the demand for seed of the Austrian Winter variety, in the expanding use of the strain as a cover crop in the South, is increasing yearly.

As feed for pigs peas are extremely efficient and have the added virtue of producing a firmer bacon than on corn alone. In Utah and South Dakota less peas were required to produce a pound of pork than when corn was fed. Experience in Minnesota and Wisconsin agrees

with these findings. Peas, wheat screenings and skim milk have been widely used in pig rations to produce the lean, firm bacon demanded by the English market. At one time the packers offered a premium of 75 cents a 100 pounds live weight of hogs fed on such a diet. Peas mixed with ground oats, shorts or wheat bran make an excellent ration for brood sows, ewes in milk, lambs, milch cows, horses at work and colts. Indeed in the early fattening stages of all farm animals before full maturity is reached there is no better grain ration than peas. For sheep, poultry and hogs peas need not be ground, but for other animals it is considered advantageous to grind. Pea meal is a rather heavy feeding stuff and may well be lightened by mixing with bran or other material, as just mentioned.

Pea straw, when properly cured, is better and more relished by cattle, horses and sheep than the straw of other small grains. Vines cut with a pea harvester, cured and put up without being rained upon, approach clover in feeding value. Sown with oats or barley, peas make a good forage crop for hay or pasture, especially for hogs and sheep. For hay it should be cut just before the maturity of the predominant crop in the mixture. Peas are at their best for pasture at the time grasses begin to fail by reason of the dry weather of summer. Peas grown for hogs or sheep need not be threshed or run through a cutting box, but should be fed vines and all. Those animals are able to handle the material without man's help.

On mixed pea and grain pasture stock should be confined by movable fences to one part of the field at a time. Otherwise the animals may roam at will and waste much of the crop. In Wyoming it was found that hogs would fatten on such pasture in 60 to 90 days, making a gain of about a pound a day per hog.

Peas are subject to several diseases some of which, such as wilt, powdery mildew and root rot, may be serious. The most practical remedies for these troubles are the use of disease resistant varieties, and systematic rotation with other crops. The chief insect enemy of peas is the pea weevil, a snout beetle resembling the bean weevil, of a black color with a few white spots. Its eggs are laid on the pods, one for each pea, and the grub on hatching eats its way through the pod into the peas. The best treatment for infested seed peas is to fumigate them with bisulphid of carbon in a tight container, applying 1 to 2 ounces per 100 pounds of seed for about 48 hours.

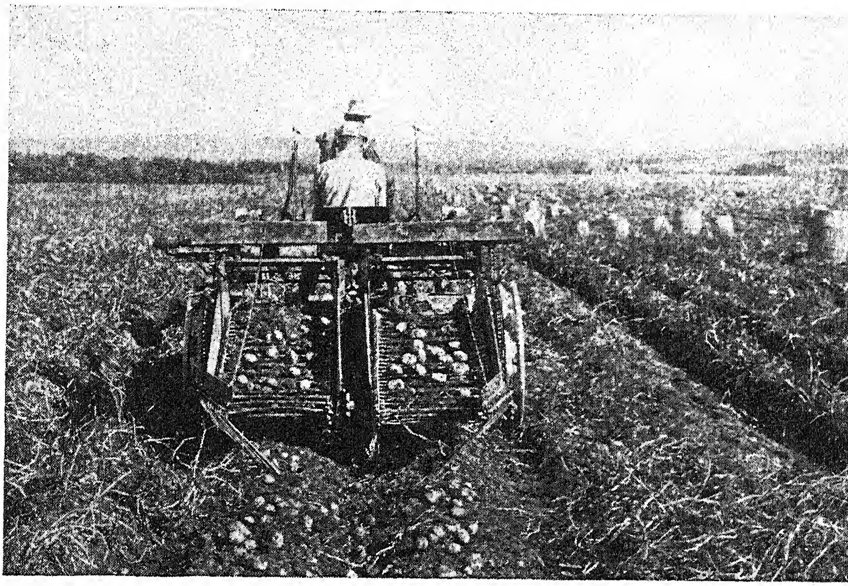
POTATO (*Solanum tuberosum*)

The potato is one of the most important farm crops which originated in America. It has been carried to all parts of the world, particularly to Europe, South America and Australia. Russia, France, Poland, and Germany in normal times each surpasses us in yearly production. Since 1930 our production has ranged from 330 to 406 million bushels. About 400,000,000 bushels seem to be all the potatoes the country will normally consume unless prices are considerably reduced. In years when the production has been above the dividing line, the March prices have been little if any higher than the December prices, and it has not paid the farmer to hold his potatoes later than December 1st. This indicates that potato eaters do not need more then 400,000,000 bushels a year. Acre yields are improving all over the country. The average yield for the decade 1880-1890 was 73 bushels, but the average for 1910-1920 was 97 bushels, while in 1941 the average was 132 bushels per acre.

The potato crop of the country is commonly divided into early, or truck crop, and the later, or main crop. At least 30 northern and western States take part in producing late potatoes, while 11 southern States and California, which also raises a late crop, grow the early truck crops. As a matter of fact the line of division is not very sharp. From the time of the earliest arrival of new spring potatoes from Palatka and other Florida areas, till the final harvest in the northern tip of Aroostook County, Maine, later arrivals come to market, with the advance of the season northward from the Carolinas, Virginia, New Jersey, Long Island and on to Maine.

In yield per acre California heads the list with 310 bushels per acre in 1941, followed by Washington, Oregon, Idaho, Rhode Island, New Jersey, and Connecticut. The principal potato States are New York, Minnesota, Wisconsin, Michigan, Maine and Pennsylvania. During the past decade these six States have raised 46 per cent of the national potato crop. The potato thrives best where the summer temperatures are relatively low, and where irrigation water is available, or where the annual rainfall is ample and well distributed. But as William Stuart suggests "it would be misleading to assume that because the six States just

mentioned produce such a large part of the total crop from the 30 late-crop States, they are better adapted to potato growing than Colorado or Idaho. The real reason is that they are better located with respect to the large consuming centers and have an advantage in freight rates." The local distribution of large producing areas within the chief potato States is quite irregular except, that in Maine Aroostook County is the chief center, as is the Red River Valley for Minnesota, the western part of New York for that State, the Yakima Valley for Washington, Greeley and the San Luis Valley for Colorado and the deltas of the San Joaquin and Sacramento Rivers for California.



MOTOR POTATO DIGGER

Soils. The heaviest yields of potatoes, and potatoes of the best qualities, are grown on rich, sandy loams which are well supplied with organic matter and naturally well drained. The crop is grown, however, and very successfully, on nearly all kinds of soil. On heavy clays the tubers tend to sogginess. All stiff soils should be lightened by drainage and by plowing under green crops and barnyard manure. Newly cleared forest land is especially desirable for potatoes. It is of prime importance that the soil be not only fertile, but in good mechanical condition, loose, friable, deep and mellow. The crop does especially well on heavy clover sod or after a good crop of cowpeas. Owing to the scab and other potato diseases a clean crop cannot be successfully grown on the same ground year after year, thus making rotation with other crops essential. A successful 3-years' rotation in many large potato districts consists of fall wheat seeded to clover in the spring the first year; clover, the second season, plowed under in fall or winter; and potatoes the third year.

Next to a fertile soil thorough preparation before planting is one of the most important factors in successful potato growing. Heavy soils should be plowed in the fall and exposed to the action of winter frosts. The plowing should be deep and cultivation frequent, and at the time of planting the soil should be mellow and loose. The roots of the potato feed deep, though the tubers are generally formed within 6 inches of the surface.

Fertilizers. Except on rich garden soils or soils abundantly supplied with humus, the best fertilizer for potatoes is well-rotted barnyard manure. When applied directly to the potato crop the tubers are likely to be scabby. It is, therefore, usually applied to the preceding crop, but in such abundance as to leave the land well prepared for potatoes. Potatoes do well after a heavily manured corn, clover or grass crop. On soils that have been made rich in humus by the

application of barnyard manure or the plowing under of green crops, commercial fertilizers will be found of most value. Generally the use of a complete fertilizer will give the best results. A complete fertilizer is one that contains nitrogen, phosphoric acid and potash. Nitrate of soda is one of the best sources of nitrogen for potatoes. In many tests of potash fertilizers for potatoes the best quality of potatoes, i.e., potatoes rich in starch, have been obtained by the use of sulphate of potash. Equally as heavy yields have been obtained when kainit, muriate of potash, or unleached wood ashes have been used. The superphosphates are most valuable as sources of phosphoric acid. Thomas slag at the Ohio Station proved a better source of phosphoric acid for potatoes than either dissolved bone-black or acid phosphate. There are many special potato fertilizers on the market. These generally contain relatively large amounts of potash.

"Recent studies indicate that the ideal method of applying fertilizer is to place it in bands on each side of the seed piece on the same level and 2 to 3 inches away from the seed piece." The time of planting must be regulated by local climatic conditions. In general the planting should be so timed as to avoid bringing the most active period of tuber growth into the prevailing occurrence of a hot, dry spell in summer, such as may occur in New York and the middle west. "Experience has indicated" as shown by Stuart "to the growers of western New York that by planting their crop between May 20 and June 1 they obtain better results than by planting between May 1 and May 20. This is because a period of 4 to 6 weeks of heat and drouth usually occurs in that region during late July and early August. Potatoes planted in early May would be forming their tubers during that period. Potatoes not planted till early June will not be sufficiently advanced to be seriously injured by the heat and drouth." On the contrary the early crop should be planted as soon as danger from spring frost is past.

The number of seed pieces required to plant an acre varies from 4000 to 26000 according to the distances between rows and distances apart at which seed pieces are planted in the rows. According to Stuart "The number of bushels of seed employed in planting an acre of potatoes varies considerably in different parts of the country. Roughly stated, the quantity actually used varies from 5 to 20 bushels per acre. There are occasional growers who use as many as 30 bushels of seed to the acre. The southern truck grower as a rule uses the smaller quantities of seed potatoes for the reason that he is generally obliged to pay a high price for seed stock. The high price is caused by the fact that he is at a considerable distance from the source of production of the seed and by the fact that he must have it delivered during the winter season when it must be protected from damage by cold while it is in shipment. In Aroostook County, Maine, the common practice is to plant from 5 to 6 barrels of seed per acre, or from 825 to 990 pounds (13.7 to 16.5 bushels). On land well supplied with organic matter, an abundant supply of available plant food, and moisture, the use of large-sized pieces or whole tubers from 1½ to 2 ounces in weight will usually prove a profitable investment.

"A safe general rule to follow in planting potatoes is to increase or decrease the distance between the rows, as well as the hills, in accordance with the size of the seed piece used, the variety grown, the fertility of the soil, its moisture-holding capacity, and the average normal rainfall that may be expected when the plants are developing their tubers. The nearer the soil and weather conditions approach the ideal, the larger the seed piece and the closer the planting. Early-maturing varieties may be planted more closely than late-maturing sorts, because the plants, as a rule, do not grow as large."

Seed for Planting. An enormous number of experiments have been made relative to the seed used in growing a crop of potatoes. By "seed" is meant potato tubers. The seed produced in the seed-balls on the potato stalks above ground is of no value in growing a commercial crop of potatoes. It will grow, however, if planted and produce inferior tubers, and is of value in originating new sorts. The best seed potatoes generally are those grown in the locality where they are to be planted. As between those grown farther north and those farther south, those from the more northern locality should be chosen.

In the South second crop potatoes are better than first crop or Northern potatoes for seed. But Northern seed must be used for the first Southern crop. Unsprouted tubers are better than cellar sprouted tubers. When tubers are stored in a damp cellar or pit they are liable to send out long white sprouts, which must be rubbed off at planting time. The

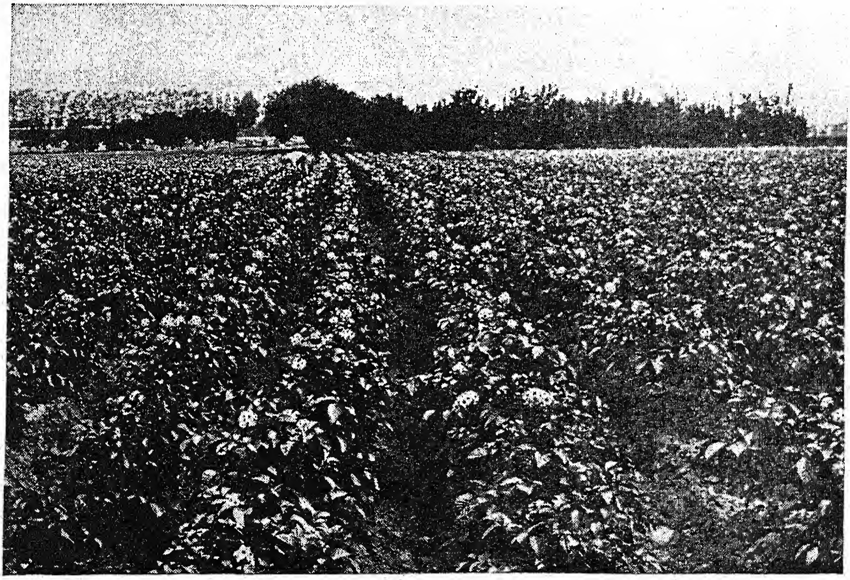
growth of these sprouts weakens the tubers. If, however, the tubers are spread out in a shallow layer in a bright, sunny room the sprouts that start are short and sturdy and will start off and grow more rapidly and thus produce an earlier crop than tubers that have not sprouted at all or that have grown long, weak sprouts in the dark.

Tubers should not be cut for seed more than a few days before they are planted. Small potatoes may be used for planting when the price of potatoes is high; but generally medium sized potatoes will give the best results. All parts of the tuber are equally valuable for planting, and it has been shown by innumerable experiments that in ordinary farm practice an increase in seed from 1 eye up to the whole potato produces an increase in the total yield, but the increase from the use of the whole potato over the half potato is not sufficient to pay for the greater amount of seed required. A good rule to observe is, that when seed is high, plant quarters; when it is cheap, use halves. With small potatoes never use anything less than halves.

In the commercial potato regions of the north and west horse-drawn machine planters are in common use, but here and there hand planters are still to be seen. The planting depth ranges from 2 to 6 inches according as the level or ridge system of cultivation is practiced and depending on soil conditions. The level system prevails in Michigan, Iowa, Wisconsin and Minnesota, while the ridge culture is practiced in Maine, New York and in irrigated sections where the water is applied in furrows between the rows.

In the western irrigated sections fertilizers are not commonly used on the potato crop. For keeping the soil in condition for the large yields which are obtained under irrigation, dependence is placed rather on crop rotations. These rotations are designed to secure the largest yields from the most profitable cash crop. One commonly used rotation consists in alfalfa 2 to 7 years, potatoes 1 year, and back to alfalfa; or sugar beets may follow potatoes. Another rotation which, according to W. C. Edmundson, has given satisfaction in Greeley, Colorado, runs 4 years: potatoes on alfalfa sod, followed by barley or oats and 2 years of alfalfa.

In the San Luis Valley, Colorado, at an elevation of about 8000 feet, potatoes are planted from May 10 to June 1, and harvesting takes place from August 15 to October 15. The ground is plowed either in the fall or spring and a horse planter is used in flat culture in rows 34 to 38 inches apart, and 12 to 14 inches apart in the row. The commercial growers have each 50 to 200 acres of potatoes, and ship most of their crop to Texas and Kansas. A common rotation in San Luis Valley is wheat, 1 year; potatoes 1 year; and



POTATOES IN BLOOM IN YAKIMA

peas 2 years. The usual method of irrigation was by ditches running through the fields 3 or 4 rods apart and permitting the water to run the whole season, but it brought alkali to the surface and the method has been largely abandoned. In all irrigated regions, when irrigation has once begun in the spring, it is necessary to continue the applications at sufficiently frequent intervals to keep the tubers growing. Otherwise they may take on irregular shapes with knobby projections. In the course of these studies it has been found that dry soils are more subject to frosts than wet soils, since water contains 6 times as much latent heat as dry soil. When, therefore, a fall frost is predicted, damage may be prevented by running water through the field during the night when the freezing temperature occurs.

In the Greeley potato region it appears that frequent applications of 2 to 4 inches of water produce larger yields than more infrequent doses of 4 to 6 inches. In general the number of applications may vary from 3 to 10, depending on the amount of rainfall and the temperature.

All large growers must provide storage capacity on the farm, since it is impossible to sell all their potatoes at digging time. In the Mountain States many potato cellars are constructed on slopes or hillsides and large enough to admit a team and wagon. The sod-covered dugout, however, is practical only where the rainfall is light.

In the South "the early potato crop" as Stuart explains, "is usually harvested before it is mature. The desire of the grower to obtain the higher prices which are usually paid for the new crop serves as an incentive to harvest potatoes oftentimes before they are really fit for shipment and certainly before they have reached maximum size. The general result of such action is to prevent a normal yield of the crop, and it very often brings unsatisfactory returns in dollars and cents. There are, however, seasons in which the market price falls so rapidly as the shipments become heavy that the grower who harvests his crop early actually receives more money for his small yield than would have been obtained from a larger crop later on. Each grower must decide for himself whether he is justified in taking the smaller yield in order to market his crop early. The grower in southern Florida who plants his early crop in the latter part of November may, under favorable conditions, begin to dig his crop in the latter part of February, but aside from very small commercial areas in southern Florida, and possibly in the Brownsville district of Texas, the harvesting of the early crop may be said to begin in the latter part of March and continue throughout the spring and early summer, ending in the northern portion of the southern group of States in August."

Potatoes are subject to a long list of diseases and insect enemies. Spraying, dusting, selection of resistant varieties and other standard treatments for these troubles are a regular feature of the business of raising potatoes for the market. In all the important potato States the Experiment Stations are constantly investigating the habits and best methods for controlling these enemies of potatoes. In case of doubt as to cause of any disease which may appear in a field of potatoes it is wise to consult those authorities. A few of the most serious pests may be briefly discussed here.

Late Blight (*Phytophthora infestans*) causes serious damage from Maine to Florida, but is not important in the Central States. Purple or black spots appear on the lower leaves first. In warm, moist weather the disease may spread so rapidly as to destroy the whole field in a few days. Affected potatoes should of course not be used for seed. Most potato varieties are susceptible to the disease, but a recently developed variety known as Sebago is highly resistant. The application of a copper fungicide is the only preventive remedy, Bordeaux Mixture being perhaps the best, in the proportion of 5 pounds each of copper sulphate and unslaked lime in 50 gallons of water. Spraying must often be started when the potato plants reach a height of 4 inches and continued up to 5 to 10 applications, or if preferred, the plants may be treated with copper-lime dust.

Brown Rot (*Phytomonas solanacearum*), first noticed as a wilting of the leaves, develops as a ring of infection in the vascular system of the stem and tuber. It is limited to the South Atlantic and Gulf States, and is sometimes controlled by heavy application of sulphur or lime to the soil in summer.

Common Scab occurs in all potato regions. The disease is too familiar to require description. The most approved treatment consists in subjecting affected tubers for 30 minutes to 2 hours to a solution of corrosive sublimate at the rate of 4 ounces of corrosive sublimate to 30 gallons of water.

In Nebraska the 2 worst insect pests

are potato flea beetle and the potato psyllid. The adult flea beetle feeds on the under surface of the leaves. These injuries often permit infection with the scab organism. Early planted fields are more likely to be damaged than late ones. Good results follow treatment with a spray of 2 pounds zinc arsenite in 40 gallons of water, or when a combined treatment for the psyllid and flea beetle is wanted. Forty gallons of diluted lime sulphur spray may be substituted for the water.

Potato psyllid, an insect somewhat resembling a miniature cicada, punctures the leaves in sucking out the plant juice and in so doing introduces the disease known as psyllid yellows, sometimes called "blight" in Nebraska.

Potatoes are also attacked by wilt, blackleg, ring rot, early blight leak and other diseases, as well as by the potato worm, white grub, Colorado beetle, blister beetle and other pests.

PRICKLY COMFREY (*Symphytum asperrimum*)

This is a rank-growing succulent forage plant. It is of value principally as a soiling crop. The plant grows to a height of 3 or 4 feet and has large, long leaves which are mucilaginous in character. It is very hardy, growing north into Michigan and Canada and affording 3 to 5 cuttings per season. A yield of over 30 tons per acre is reported from the Wisconsin Station, and a grower in New York reports a total yield of over 50 tons per acre. These are exceptional yields, however. A yield of 10 to 15 tons reported from the North Carolina Station is more nearly the average.

One of the chief objections to this plant is the difficulty experienced in getting stock to eat it. Cattle learn to like it in time, but can scarcely be induced to touch it at first. A little bran or salt sprinkled on the leaves at the first few feedings will make it more palatable. Prickly comfrey though boomed a few years ago as a wonderful forage plant, is scarcely grown anywhere in the United States. In Europe it is quite widely grown for soiling. Where good crops of corn, clover and other soiling plants can be grown the plant will find but limited use. In composition, prickly comfrey compares favorably with other succulent forage crops, but has nothing special to recommend it. It is of no use for hay.

RAMIE (*Boehmeria nivea*)

Ramie was an important source of plant fiber for making cloth in the Orient before the introduction of cotton into China about 1300 A.D. Ramie, also called China grass, was to be obtained in trade only from China and Japan until small plantings were made in the Philippines. It is grown on a small scale in Libya, Tanganyika, India, southern Europe and the Georgia Republic of Russia. The total world production is about 100,000 tons, practically none being used in U.S. spinning mills. Although ramie is one of the strongest known plant fibers, and of great durability and beautiful luster, it has little or no commercial prospect in the U.S. for the reason that so far no satisfactory machine has been devised for decorticating and degumming the fiber, and hand labor is too expensive for the purpose.

It has long been grown in the East and used in the tedious hand manufacture of fine grades of textiles. It is also used for cordage and other coarse manufactures. It has been successfully grown in some of the Gulf States and parts of California, but it is not likely to become an established industry of importance until some more successful machine has been devised for extracting the fiber.

Ramie is a semi-tropical plant growing 4 to 8 feet high. The fiber is formed in the bark. The plant grows rapidly, producing 2 to 4 annual crops without replanting, and 1 planting endures for several seasons. It is propagated by seed, roots and by layering. The usual method of propagation in this country is by roots. These are cut 4 to 6 inches long and contain several eyes. They are set in ridged rows 4 to 4½ feet apart and placed in the ground about 1 foot apart. If plants are grown from seed they must be started in hotbeds. Light, sandy alluvial soils which are fertile and hold moisture well throughout the season are recommended. The land should be plowed at least a foot deep and thoroughly harrowed.

RAPE (*Brassica napus*)

This plant is grown in this country and Canada principally as a forage for sheep, hogs and dairy cows. It is fed or pastured green and seldom if ever made into hay or put into the silo. An annual kind is grown extensively in Europe and to a limited extent in this country for the seed, which is used in the production of oil, and for feeding to cage birds. This kind is of little value as a forage plant. The rape

which has recently become so prominent in the Northern States as a forage crop is a biennial plant almost identical in appearance during its early stages of growth with the rutabaga plant, except that the root does not develop into a bulb. The top grows from 18 inches to 4 feet high and produces an abundance of tender succulent leaves greatly relished by stock.

Practically the only varieties of rape in cultivation for forage and of value for this purpose are Dwarf Essex and Dwarf Victoria Rape. Rape, like other plants of the cabbage family, grows best in the rather cool, moist weather of spring and fall. It seems especially well suited to the Northern States bordering on Canada but may be grown in the South to advantage during the late fall, winter and early spring.

Soils. Rape grows best in soils rich in vegetable matter. It is especially luxuriant on well worked muck or old pasture lands. The soil cannot be made too rich for it. On lighter soils it is apt to be dwarfed in growth and disappointing. Rich clay loams give good results. The ground should be put in fine tilth. If a crop is grown for cutting and feeding green in summer the ground should be fall plowed, then worked down in the spring as early as possible with a disc or spring tooth harrow and pulverizer.

Planting. For the early crop rape should be seeded as early in spring as the ground can be worked. If the crop is grown for fall pasturing the Michigan Station considers July 1 as about the right time to sow the main crop in that State. The crop matures for feeding in about 2 months from the time of seeding. The seed is sown either broadcast at the rate of 3 pounds per acre or in drills 30 inches apart at the rate of 2 pounds per acre. A number of experiments at the stations indicate that better results are secured by the latter method. The seed should be covered with a light harrow when broadcasted. If seeded in drills a common garden drill will answer satisfactorily on a small scale. Rape is sometimes seeded between the rows of corn at the last cultivation, but is not so satisfactory as seeding alone. The crop is also seeded in the spring with fall sown rye or spring oats, the rape coming on after these crops are harvested. At the Iowa Station rape seeded in the oats field 10 days after the oats were sown yielded at the rate of 18 tons of green forage per acre. For convenience in harvesting the oats it is recommended the rape be sown 2 or 3 weeks after the oats are sown. When rape is seeded in rows it should be cultivated 3 or 4 times before the first cutting is made, and immediately after each subsequent cutting it should again be cultivated.

Using the Crop. The Canadian Experiment Stations have used rape as a green succulent food for dairy cows with good results. No taint in the milk occurred when the rape was fed in moderate quantities immediately after milking. The Wisconsin Station found rape an excellent crop to cut and feed green to breeding ewes and lambs in July when the pastures were failing. When rape is sown early in the spring and used for feeding green, 3 cuttings can be secured in an average season. Experiments in Wisconsin indicate that the best results are obtained by cutting the plants 4 inches from the ground. The stumps readily sprout and produce succeeding crops. On good soil a yield of 30 tons of green forage per acre may be expected. The crop should be cut when it has reached its maximum growth. If allowed to stand after this it loses its succulence and palatability and becomes woody.

Hogs greatly relish rape. At the Wisconsin Station it was found that an acre of rape would pasture 20 hogs, with the grain they received, 3 months. Hogs pastured on rape ate much less grain than those not thus pastured and made fully as rapid gains. It was found that an acre of rape was equivalent in feeding value for hogs to 2767 pounds of grain (corn and shorts). For late summer and fall pasturing of hogs rape is a very desirable crop.

Rape has been found especially valuable as fall pasturage for lambs that are being fattened. Better results are secured if the fields are so arranged that the lambs can also have access to grass pasture while feeding on the rape. An acre of rape will furnish about 2 months' pasture for 20 lambs which are being fed some grain in addition. Stated in another way, an acre of rape will produce about 400 pounds of mutton. The sheep should be observed closely when first turned into the rape, as bloating may occur.

RICE

Rice is the chief cereal of the Orient, eaten daily by perhaps one-half of the world's population. Apparently rice originated in India about 4000 years ago and has subsequently spread to the rest of the Orient and Europe. Rice was brought

to Charleston, South Carolina shortly before 1700, whence it gradually moved on into North Carolina, Georgia, Louisiana, Arkansas, Texas and California, where it arrived in 1912. The Department of Agriculture estimates that 97 per cent of the worlds' rice crop is produced in the Orient—China, India, Japan, Indo China, Siam, Burma, Dutch East Indies, Philippines, Malaya and Madagascar. In the U.S. the 3 principal rice areas are the prairies of Louisiana and Texas, the Grand Prairie region of Arkansas and the Sacramento and San Joaquin Valleys of California. Louisiana produces 40 per cent of the U.S. rice crop, and Arkansas, Texas, and California about 20 per cent each, the total now being nearly 33 million bushels annually.

The climatic requirements of rice are high temperature during the growing season, an abundant and dependable source of water for irrigation, a close-textured or relatively impervious soil and subsoil to prevent excessive loss of water by seepage, and provision of steady surface drainage. The land on which rice is grown is submerged under water for 60 to 90 days during the growing season. In the Southern States as soon as the rice reaches a height of 6 to 8 inches the field is submerged 1 to 2 inches in water, the depth of the water being gradually increased to about 5 inches and kept at that level until time to drain the land in preparation for harvesting, or about 2 weeks before the crop is ripe. In California several irrigations with intervening drainage are necessary to germinate the seed and promote growth for about 30 days after emergence when the land is submerged to the required depth and kept under water for 90 to 140 days. Irrigation water is allowed to enter the upper part of the plantation and to flow gently to the lower fields through prepared notches in the levees which surround each field. In that way a constant depth of water is maintained and the water is prevented from becoming stagnant. In the Philippines and Java where steep mountain sides are terraced far up the slopes, the terraces are often no more than 2 feet wide, the water in each narrow terrace belt being held in place by dykes on contour lines, while the water runs downward through shallow notches in the dykes so smoothed by hand that the water slips over without causing the slightest erosion. In the Southern States irrigation water comes from sluggish streams or from pumped wells. California gets its water from melting mountain snows.

Rice will thrive on a great variety of soils but preferably the soil should be heavy. Otherwise the 2-week drainage period before harvesting will not produce a firm enough surface to support the harvesting machinery. Crop rotation is a difficult matter with rice. Leveling the dykes and rebuilding them involves too much labor. Sometimes the rice fields are allowed to go to pasture for a year or two. Fallowing or planting cotton or corn may be practised between rice crops. In California wheat or barley may be rotated with rice but not much success followed the use of grain sorghums, corn, beans or cotton for this purpose. In a test at the Louisiana Station a piece of land has been planted continuously to rice for 50 years and without fertilizer of any kind. The acre yield has varied from year to year but has shown no continuous decline. The highest 6-year average yield at this station was from plots rotated with pasture stubble. When cotton was used in rotation with rice the yield of rice was greatly reduced, probably because of the residual poisonous effect of the calcium arsenate dusted on the cotton to kill the boll weevil.

Some of the rice land of the South is so low, wet and stiff that it is plowed under water, as is the practice in much of the Orient. Rice is planted in the South by drill or broadcast usually from April 1 to May 15. Late seeding has the advantage that the weeds may already have started and may be killed by cultivation before seeding. In the Orient, where young rice plants are set out in rows by hand directly from the nursery beds, weeding is done by the simple process of having the laborers wade through the fields barefoot and tramp the weeds down into the mud. By drill 90 to 100 pounds of seed is enough per acre, or 120 to 150 pounds if broadcast. In California the fields may be flooded before seeding, and the seed sown in the water by airplane or by endgate seeder drawn by horses.

Harvesting is done in California with binders or combines. The rice is usually ready for cutting within 10 to 18 days after the water is turned off. In the South most of the harvesting is done by grain binders drawn by horses, mules or tractors.

The commercial rices of California, as stated by J. W. Jones, are all of the short grain type such as the Caloro and Colusa varieties. In the South a large range of

types are grown varying in height from 36 to 58 inches, and in time of maturity from 120 to 140 days or more. Most of the Southern rice is of the medium length of grain belonging to the varieties Blue Rose and Early Prolific which were originated by the noted rice breeder, Sol Wright, who migrated from Oregon to Crowley, Louisiana in 1890, and produced a long list of rice strains which at one time dominated the rice belt of the U.S. from Louisiana to California.

Rice is commonly described as being ready for harvest when the panicles are well turned down, yellowish in color, and the lower kernels in the hard dough stage. If harvested before this stage the quality may be lowered and the yield reduced by the presence of immature kernels. If harvested after this stage, there may be loss from shattering.

One of the serious obstacles to rice growing is weeds, chief of which is red rice. This is a wild, hardy rice and its presence in the cleaned rice reduces the price. It is recommended that the rice field be plowed soon after harvesting, well cultivated and then seeded to oats or like crop as a means of suppressing it. No seed containing red rice should be planted.

The level prairie lands of southeastern Texas and southwestern Louisiana have been found especially well suited to commercial rice growing. The level lands make possible fields of 40 to 80 acres in extent, so that all modern machinery can be used in growing and harvesting the crop. Many pumping stations along streams have been built, artesian wells put in and hundreds of miles of canals built. The industry in this section of the country is steadily growing in extent each year.

Rice is principally used for human consumption. Rice meal, which is a by-product in the preparation of rice grain for the market, is of considerable value as a stock food.

ROTATION OF CROPS

This term refers to the order in which crops are made to follow each other in different years on the farm. With most crops and on most soils rotation is very desirable. If potatoes are made to follow potatoes year after year the ground soon becomes so infected with disease that only scabby tubers can be grown. If clover is made to follow clover the soil becomes "clover sick" and the crop fails. Land kept continually in cereals becomes foul with weeds. The strawberry field long kept in strawberries becomes filled with injurious insects. Besides, the roots of many plants feed only in the shallow surface soil, leaving stores of food deeper in the ground untouched. It is desirable that such crops be rotated with deeper feeding crops so that the whole food supply of the soil may be utilized. Some plants use only the food stored in the soil and thus tend to impoverish the land. Others like legumes draw a portion of their food from the air and thus become in a measure soil enrichers. Again different crops draw unequally on the different food elements of the soil. A crop of peas or beans draws heavily on the potash and lime in the soil, while a crop of wheat requires relatively small amounts of lime and potash but large amounts of phosphoric acid. The same soil will therefore more easily produce a large crop of beans and a large crop of wheat following each other than 2 successive crops of wheat or 2 crops of beans.

For all these reasons—the maintenance of soil fertility, the renovation of impoverished soils, the production of large crops, the destruction of insect and weed pests, and the more economical distribution of labor throughout the year and hence greater profits—a proper system of rotation is considered essential to continued success in modern farming.

Systems of crop rotation are generally designated by the number of crops entering into them. If 3 crops enter into the rotation it is known as a 3-course rotation; if 4 crops a 4-course rotation etc. One of the very successful rotations observed in some portions of Ohio is a 3-course rotation consisting of wheat, clover and potatoes. Wheat is grown the first year, clover the second, and potatoes the third, and then wheat again and the rotation repeated. The rotation to be observed on different farms will necessarily vary with the nature of the soil, markets, etc., and so no one system can be given which will serve as a guide for all farms. In general a rotation should be so planned as to secure about the same amount of forage to feed each year and of grain and stock to sell.

Systematic rotation is not as common in this country as it should be. The rich, seemingly inexhaustible soils of many of the Western States are not quick to show the need of rotation. Where rotation is practiced a 3-crop system is more common than a 4-crop system. Wheat 1 year followed by clover and grass 2 years, then corn with the manure made on the farm applied to the corn crop is common. A

good 4-course rotation for the Northern States consists of wheat or rye followed by clover and grass, then corn with the manure of the farm applied to the corn crop. Oats follow the corn. The corn should be kept thoroughly cultivated to kill the weeds that start, and at the last cultivation rye should be sown between the rows to furnish late fall and early spring pasture. The rye is turned under early in the spring. Oats follow the rye. When the oats are harvested the ground is immediately prepared for wheat. Timothy is seeded with wheat in the fall and clover in the spring. Corn follows the clover crop, and the rotation repeated. This is not an ideal rotation but gives good results.

The Rhode Island Station has greatly improved light and impoverished land by the following rotation: One: 3-course, potatoes, winter rye, clover; two: 4-course, corn, potatoes, rye, clover; and three: 5-course rotation, corn, potatoes, rye, grass and clover for 2 years. Commercial fertilizers also were used. At the Delaware Station a good rotation for poor soil in bad condition was sweet corn followed by crimson clover the first year, cowpeas followed by winter oats the second year, and clover the third. For the South the Louisiana Station recommends the following rotation: Corn first year, oats followed by cowpeas the second, and cotton the third year. Suitable rotations for dairy farms are noted under SOILING. In many Western and some Eastern States summer fallowing is practiced at stated intervals. This is for the purpose of giving the land a rest and freeing it from weeds. No crop is grown and the ground is kept cultivated during the season. Experiments repeatedly made have shown that this is not an economical practice. No return whatever is obtained from the use of the land for a whole season and if rain prevails much of the plant food of the soil is leached out.

The value of fallow is influenced materially by the nature of the soil and its depth. The value of fallow is determined by the amount of moisture stored in the soil during the fallow period. Sands, loamy sands and light sandy loams have low water holding capacities and therefore the amount of water that can be stored in such soils is relatively small. The light sandy soils also permit ready penetration of moisture and thus most of the rainfall received during the growing season becomes available to plants. For these reasons fallowing in general is not practical on such soils except where they have a relatively heavy subsoil.

Soils that are shallow have a limited water holding capacity and for this reason usually cannot be fallowed economically. If the fallow is to be successful in storing moisture the soil must be favorable for moisture storage to a depth of 3 feet or more.

Soil types that occupy a hilly, rolling or steeply sloping topography cannot be fallowed as successfully as can those with a more level topography because of the loss of water by runoff. When soils so situated are fallowed they should be cultivated on the contour and under some conditions should be terraced or strip-cropped.

Definite cropping systems are seldom used in central and western Kansas. Some fields are commonly seeded to wheat for many years in succession while others are used for the production of feed crops year after year. By the introduction of fallow a good cropping system can be adapted to most farms. In the extreme western part of the State, including about two tiers of counties, all crops should be alternated with summer fallow. Thus the cropping systems would become wheat, fallow, sorghum, fallow.

Soil is rested when it is given a change of crop. It is better to grow some cultivated crop like corn or roots and seed down in the latter part of the season to some cover crop like rye, hairy vetch, etc. The cultivation during the early part of the season will kill the weeds and the cover crop smother any that remain, besides holding the soluble plant foods for the use of succeeding crops.

Some of the general principles that should guide in laying out a systematic rotation are as follows: (1) Have at least one leguminous crop in the rotation. (2) Have at least one cultivated crop. (3) Rotate shallow rooting crops with deep rooting crops. (4) In the South and on leachy soils plan to have a growing crop on the land all the time. (5) Avoid bare summer fallowing. (6) Do not rotate small cereals with other small cereals. (7) Plan the rotation so as to have about the same amount of forage each year. (8) Keep stock on the farm. (9) Unless it is thoroughly rotted apply the barnyard manure thus made to the rank growing crop in the rotation like corn.

RYE (*Secale cereale*)

Rye cultivation has ranged from 5 to 7 million acres in the U.S. since 1931, with a total production of 17 to 55 million

bushels, or about 13 bushels per acre. The leading rye States are North Dakota, South Dakota, Nebraska, Minnesota, Indiana and Ohio, but the crop is raised on a smaller scale in nearly all States. The present estimated world total is 1½ billion bushels.

Rye is grown in this country chiefly for forage and bread, but some of the grain is used for malting, and the straw is a paper source of some importance. The relative place that rye occupies in the world's food basket may be expressed in figures by reminding ourselves that corn furnishes 112 million tons; wheat, 110; rice, 90; oats, 65; barley, 50; rye, 45; and millet perhaps 10 million tons. Americans are not great consumers of rye, about 18 pounds a year per capita, as compared with 500 pounds by Danes and 200 by Belgians. In times of normal world trade a large part of our rye has been exported to Europe.

Rye is mentioned as being grown in New England within a few years after the arrival of the Pilgrims, and in 1726 Connecticut passed a law ordering the destruction of barberries because they increased the prevalence of rust on rye and other grains. Rye, however, is decidedly less susceptible to rust and drouth than wheat. It matures too early to be caught by rust or drouth, and is also relatively immune to the attacks of Hessian fly.

Farmers quite generally report that rye will thrive on thin, poor, acid, sandy, wornout or impoverished soils not adapted to wheat. Sometimes the fact that rye will grow on poor soil has been twisted around to mean that it is grown only because the soil is not good enough for wheat. Thus rye came to be looked upon as a badge of poor farming. But in Minnesota rye is a serious competitor with wheat, and in bad years is a surer crop. The harvest begins in Minnesota by July 4 and is over by July 10. Then sowing again by September 10 to 20 a good rye pasture is secured for both fall and spring without injuring the crop for grain. Moreover, in Minnesota the average yield of rye is 16 bushels as compared with 14 for wheat, and on good wheat land may reach 30 to 50 bushels per acre.

Rye flour is used extensively in Wisconsin, the preferred variety being Pedigree. It averages 17 bushels per acre. Rye has proved the best of all nurse crops for clover, the rye being sown in September and the clover seed broadcast on the snow the next spring.

Michigan made a great contribution to the rye industry by producing the Rosen rye which outyielded other varieties and produced plumper and more uniform kernels. Some farmers in Michigan seed timothy with rye in the fall. Others sow red clover or sweet clover with the rye the following spring. A mixture of rye and vetch is also well liked.

North Dakota farmers had a painful experience with rye. Rye being so hardy, they tried the experiment of merely stubbling it into the old wheat fields without any soil preparation. That plan left the grasshopper eggs undisturbed to hatch the next spring and devour the rye crop. In Iowa a favorite use of rye is as a pasture crop. By sowing rye about September 15, or in corn at the last cultivation, it provides pasture from October 15 to December 15 and again in April. Rye is a poor competitor with wheat for grain in Iowa, Kansas or Nebraska.

But in the South rye has been found to be one of the surest and best cover crops for all that region. It is easy to get started, easy to raise. Rye furnishes excellent hog pasture from Christmas till spring. Good year-round pasture is provided by rye, rape, Bermuda grass and soy beans, grazing them in the order named.

Soil. The best quality of rye grain for bread is grown on a rather dry, sandy soil of medium fertility. A fair crop of rye can be secured on soil too poor to produce wheat or corn and with less care. It will not thrive on wet soils and heavy clays are not favorable to its best growth. The heaviest yield of grain and the greatest amount of forage are produced on the lighter, fertile, well-drained loams.

Seeding. The seedbed for rye is prepared in the same manner as for wheat. Rye is likewise seeded about the same time or just before wheat, no matter whether spring or winter varieties are used. Early seeding is especially desirable on poor soils, since with winter varieties of rye it gives the plants opportunity to become well rooted and tillered before severe weather sets in. When seeded on light soils the seedbed should be rolled after seeding except in the drier, windier sections of the West, where the ground should be left rough to retain snow. Seeding with a drill gives better results on the average than broadcasting. The seed should be put in from 1 to 2½ inches deep, depending on the lightness and dryness of the soil. Where seeded early and on poor soils seeding at the rate of 3 to 4 pecks per acre is considered about right.

On the better soils, or when seeded late, 1½ to 2 bushels is sown. Where the crop is grown for forage heavier seeding still is desirable, 3 or even 4 bushels per acre being used.

Rye sown in September at the Vermont Station gave an abundance of green forage for cows by the middle of May. After May the stalks became tough and unpalatable. The amount of rye forage will be considerably increased if it is grown after some leguminous crop like clover, cowpeas, or soy beans.

Harvesting. Winter rye ripens before wheat. The grain is ready to cut when the straw changes color and the kernel passes into the hard dough stage. The crop is harvested and cared for in the same manner as wheat. Special machines are in use for threshing out the grain without mutilating the straw. This is of considerable advantage where the straw is used for packing or making into paper.

Feeding Value. Scarcely any experiments have been reported from the American experiment stations on the value of rye for feeding to stock. The composition of the grain is very similar to wheat. The matured straw has a very low feeding value. Foreign experiments show that when the grain is fed to milch cows it gives the butter an undesirable and sometimes bitter flavor. Fed to hogs it produces a good quality of pork and would seem to be about equal for this purpose to barley. Rye shorts fed alone appear to give a soft pork of poor quality. The South Dakota Station states that a field of winter rye pastured close in the spring by sheep then yielded 18 bushels to the acre.

Ergot, a specific disease of rye, appears as black spurs replacing the kernel. It is common also on wild rye grass and bluejoint. Rye is also attacked by rust smut and various insect enemies which are discussed under wheat.

SALTBUSHES (*Atriplex* spp.)

Low, shrubby, much branched plants, especially valuable on some of the arid and alkaline soils of the West for forage. There are many native species of these plants. Many others have been introduced from Australia. The most generally useful species thus far cultivated agriculturally is *A. semibaccata*, introduced from Australia. This is a rapid growing perennial, thriving alike on soils containing as much as ⅓ of 1 per cent of alkali in the surface foot of soil and on arid non-alkaline hardpan uplands. At the California Station single plants sometimes reach a spread of 12 feet. It is quite hardy, withstanding a temperature of at least 14 degrees F. It has produced 5 tons of dry forage per acre on land where no other useful crop would grow, and with a rainfall of less than 4 inches. The forage is eaten by all stock, although they sometimes do not relish it at first. Analyses show it to have nearly the same nutritive ratio as alfalfa. The California Station states as a result of 18 years' experience in growing saltbushes, that this species "is unsurpassed among the gifts of nature to the deserts and the alkali wastes which cover so large a part of the earth's surface."

Saltbushes may be grown from cuttings, but are usually grown from seed. Station experiments in California indicate that on alkali soils the seed should be sown on top of the ground and well firmed in, but not covered. The best time for seeding in the warm districts in that State is early in October before the rains come. In experiments in seeding on non-alkaline, arid uplands the best results were secured when the seed was covered ⅛ inch deep. When covered ½ inch deep only 25 per cent of the seed sprouted. The seed may also be sprouted in boxes and transplanted in rows 4 feet apart on light or hardpan soils and 6 to 8 feet apart on alkali soils. The plants should stand from 1 to 4 feet apart in the rows. The young plants on being set out are treated like young cabbage plants.

SORGHUMS

Most of the numerous farm crops which are commonly grouped under the name sorghum came to the United States from Africa and Asia. The classification adopted by J. H. Martin of the Department of Agriculture puts these plants into four types—grain sorghums, such as Kafir, milo, feterita, etc., sorgos or sweet sorghums, often called cane, used for forage or sirup, broom corn and grass sorghums, including Sudan grass. In this volume broom corn is discussed under its own name, while Sudan grass will be found under Grasses. The other sorghums will be considered as a group in the following article. Over 100 million bushels of grain from these sorghums are produced annually in this country on an area of about 10 million acres, the principal producing States being Texas, Kansas, Oklahoma, Nebraska, Colorado, South Dakota, California, New Mexico and Missouri. The main sorghum belt extends

from Texas northward to Minnesota and North Dakota. The northern progress has been made possible by the creation of new early maturing varieties. Success with sorghums now seems possible within the limits of 17 to 40 inches of rainfall and an average frost-free period of 160 days. Sorghums should not be planted till after the danger of spring frost is past. Some of them may mature in 80 days, and others within 100 to 120 days but a few require 160 days.

More than 40 types of grain sorghums are in cultivation in the United States and their number is being constantly added to by farmers and breeders in various States. Some of these are discussed in the following paragraphs.

Chicken Corn (*Sorghum vulgare var.*). This is a veriety of sorghum which has become naturalized and grows wild over a considerable portion of Western Alabama and Eastern Mississippi. In many cultivated fields it is a serious weed pest and has to be cut down 4 or 5 times during the season. The plant in appearance is similar to ordinary broom corn, though the heads are less spreading and the stalks usually branch at several of the joints, so that each bears a number of heads. It is especially abundant in cornfields, starting into growth after the corn is laid by. It matures rapidly and by September the corn in many fields is entirely hidden, and it appears as though the field were planted with common sorghum.

If cut before heading the plant makes excellent hay. At the Alabama Canebrake Station it yielded at the rate of 22,520 pounds of green fodder per acre at the first cutting, which was used for silage, and gave 3760 pounds of cured hay at the second cutting, September 30. When the crop is allowed to mature the yield of seed is about the same as that of the ordinary cultivated varieties and is worth about as much for stock feed. In feeding experiments with hard working mules at the Mississippi Station chicken corn grain proved about equal in the ration to corn. That station further states that the seed can be gathered at an expense of 10 cents per bushel and that many planters make a practice of saving it to use in place of corn, though it is sometimes difficult to keep on account of the attacks of weevils.

The crop is considered excellent for silage. In seeding for this purpose the Alabama Canebrake Station recommends that it be planted in rows 3 feet apart and from 12 to 18 inches in the drill. When sown broadcast the crop seems to be hard to handle. A crop seeded April 2 matured for silage July 20.

Durra (*Sorghum vulgare var.*). This is a non-saccharine sorghum which is used as a forage crop. It is similar to Kafir corn and Milo maize. Indian millet and Egyptian corn are other names sometimes applied to it. Besides the use of the stalks and leaves as forage the grain is used as a stock food, and in some of the valleys of California is substituted for barley for horses. It is very similar in composition and feeding value to corn.

Where corn will do well there is no advantage in growing durra. Its chief advantages are its drouth-withstanding properties, and the fact that it will do better on poor land than corn. In periods of drouth the plant may make no growth but pick up and grow again with rain where corn would be an entire failure. Durra grows from 4 to 8 or even 12 feet high, has sheathing leaves 2 inches broad and about 2½ feet long, and yields an abundance of grain in a broom-corn like head. It has been found most valuable in the semi-arid regions of the Southwest and West.

Experiments at the Kansas Station indicate that durra should be sown in drills 3 feet apart and the seed scattered 4 to 8 inches distant in the drill. It requires the same cultivation as corn. When the seeds become hard the crop should be cut and shocked. The whole plant may then be fed as forage in racks to stock. Much of the grain fed in this manner passes through the animals whole. For best results the heads should be cut off and threshed and the grain ground as fine as possible before feeding.

There are two varieties of durra, brown and white. At the Kansas Station brown durra grew vigorously, producing from 5 to 10 full sized stalks from a single seed. The stalks were tall, coarse, jointed, with very heavy foliage and very juicy. A large percentage of the heads did not mature. The seed of brown durra is light yellow in color and slightly flattened. The heads are short, thick and heavy, hanging pendent on a short "goose-neck." The station advises that the heads be cut off before the stalks are cut if the seed has matured. This makes the handling of the crop much easier. One season the yield at the Kansas Station was 13½ tons of dry fodder and 40 bushels of seed per acre. Another season but 7 tons of dry fodder was secured and no grain. Owing

to the late maturing habit of brown durra it is not considered by the station as good a substitute for corn as some other crops.

At the Wyoming Station brown durra matured seed in 123 days and yielded at the rate of 19,200 pounds of fodder per acre. It is recommended as a profitable forage crop for some portions of that State. At the New Mexico Station durra is reported to make 3 or 4 cuttings of good feed.

White durra or Large African millet grows 8 to 10 feet high without suckers or shoots. The heads when well developed are 12 to 20 inches or more long. If the whole stalk is cut down and cured in shocks when the seed is in the dough state a very excellent forage is produced. Cut earlier in the season, a second crop sprouts up at once. The grain is white, with a pinkish tint, and weighs about 60 pounds per bushel. This variety matured at the Louisiana Station in from 90 to 100 days. The forage cured readily in 4 hours of sunshine. The crop yielded 12.54 tons of excellent hay and 43.16 bushels of seed per acre.

Egyptian Rice Corn (*Sorghum vulgare var.*). A non-saccharine sorghum forage plant similar to durra, but not so productive. The plant tillers very little, grows from 4 to 6 feet high, with but few leaves, and bears a plump, round seed head on a short "goose-neck" stem. The seeds are white, with black glumes, large and sweet. At the Louisiana Station it matured in July and August. It is cultivated liked durra and used for the same purposes. It is suitable for green food and cures into good hay. The seed makes excellent feed, but shells out readily in handling and should therefore be cut before it is ripe. At the Kansas Station the yield one year was 3.47 tons of dry forage and 16½ bushels of clean seed. At the Louisiana Station the yield was 11 tons of hay and 22 bushels of seed per acre. At the Colorado Station the total yield was 4.1 tons of dry matter per acre. The Arizona Station reports it the best heat and drouth resistant plant of a number of forage crops tested.

Feterita is rather less leafy than Kafir or Milo. The seeds are slightly larger and the heads beardless. It is adapted for use as a summer catch crop, matures a little earlier, and is more drouth resistant than Kafir. There are several varieties of feterita, of which the standard and the dwarf have proved successful in Texas.

Kafir Corn (*Andropogon sorghum var.*). A non-saccharine sorghum introduced from South Africa about 60 years ago and now grown to a considerable extent in Kansas, Oklahoma, California and some other South and Western States as a stock forage and grain crop. The plant grows erect 4 to 7 feet high. The stalks are thick, short jointed, with broad leaves somewhat shorter and stiffer than

DELTA SORGHUM

corn leaves. The heads are compact, erect, 10 to 15 inches long. The chief value of the plant is as a grain crop in semi-arid regions where the soil is too poor or the drouths too severe for corn.

The crop is adapted to all soils, but makes its best development on rich corn lands. Profitable crops of Kafir corn can also be produced on soils too poor for corn. During drouths the Kafir may cease to grow and the leaves curl up, as do corn leaves, but they remain green and with the first rain start into growth again. If the stalks are cut they sprout up again, producing a second and even a third crop.

In Michigan, North Dakota, New Jersey and the Northern and Eastern States generally Kafir corn has given poorer yields of both forage and grain than Indian corn. Generally speaking, Kafir corn has no place in Northern humid agriculture. In such regions corn yields more and is a better crop to feed.

Seeding. The seedbed for Kafir corn should be prepared exactly as for corn. The finer the tilth the better. The best yields have been obtained in Kansas and Oklahoma when the seeds were drilled in 3 to 5 inches apart in rows 3 feet apart. It is better to seed too thick than too thin. The experiment stations have seeded the crop very successfully with a grain drill by leaving the first and fifth feeds open and closing the others. By drilling a little on bare, hard ground the feed bar can soon be adjusted so that about the right amount is sown. It should be drilled in about as deep as wheat. From 6 to 7 pounds of seed is sufficient to plant an acre. Listing may be practiced with Kafir corn. The slow weak growth of the crop for the first 6 weeks after planting makes this practice generally undesirable, except possibly on warm soils and in late planting. The seedbed should be pulverized just before planting in order to kill all weeds.

Kafir corn grows best in warm weather, and as a rule should not be planted until after corn. If planted earlier, when the ground is cold, much of the seed is liable to rot and reseeding become necessary.

Harvesting. Kafir corn matures its seed in from 12 to 14 weeks. The plant remains green, however, until late fall. If both grain and fodder are wanted the crop should be cut as soon as the seed is ripe and put in large shocks to cure. The corn binder is the most convenient machine for cutting the stalks; but any of the methods of corn cutting applies equally to Kafir corn. For stock horses and cattle the shocks may be hauled directly to the feed lot; but when animals are to be fattened the grain should be threshed and ground. Kafir corn cut and shocked in September will not be cured sufficiently for threshing before November.

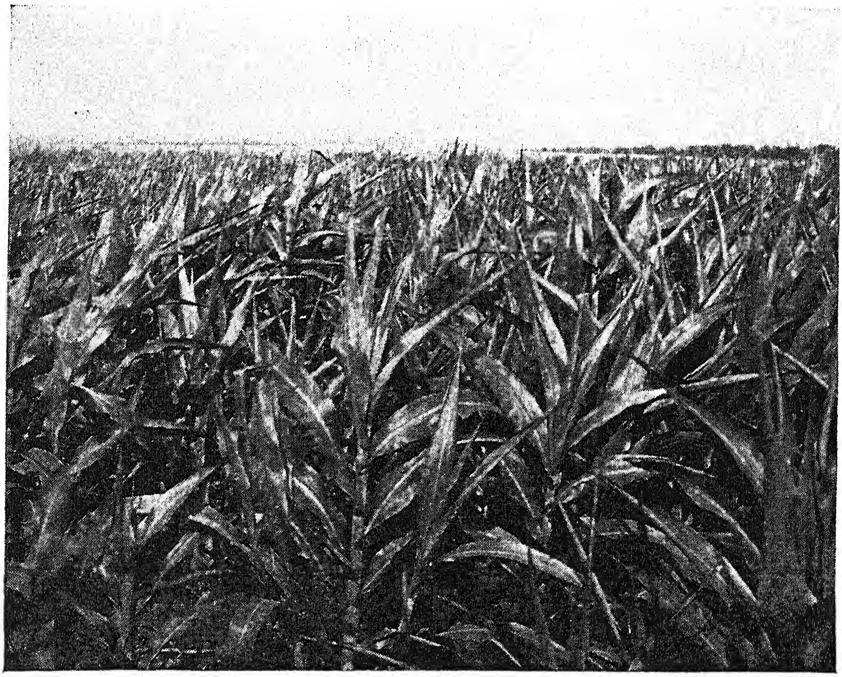
Heading by hand, heading by machinery, cutting with a row binder and use of a combine are the methods for threshing Kafir corn. Threshed Kafir corn grain stored in bins is almost certain to heat in damp weather. It should be carefully watched and shoveled over when necessary.

Use. Kafir corn grain is used like corn for fattening hogs, cattle, poultry and all farm stock, though pound for pound it is not so valuable for fattening purposes, nor does it appear to be so greatly relished. According to the North Carolina Station mature Kafir corn contains 16.23 per cent water, 2.02 per cent ash, 6.92 per cent protein, 6.79 per cent fiber, 65.18 per cent nitrogen free extract, and 2.86 per cent fat. A bushel of Kafir corn produced 10.6 pounds of pork at the Kansas Station and a bushel of corn 11.9 pounds. Owing to the greater yield of Kafir corn an acre produced 487 pounds of pork, while an acre of corn produced but 410 pounds. For hogs the best results have been secured when alfalfa, skim milk or soy beans have been fed with the Kafir corn. Fed on Kafir corn alone the hogs soon got so they loathed it.

With fattening steers at the same station Kafir corn has not been found quite equal to corn, but when fed with alfalfa it made the cheapest combination for dairy cows. It was fed in the proportion of 20 pounds of alfalfa to 8 pounds of Kafir corn. Kafir corn meal is somewhat constipating and has been found especially valuable to feed with skim milk to calves. For horses, the grain may be fed in the head. For colts and horses not working the stalks and heads may be fed together.

At the Oklahoma Station coarsely ground Kafir corn contained 40 per cent more digestible matter than the whole grain. Generally, for all farm animals, the grain should be ground. Chickens at the Oklahoma Station, however, digested the whole grain more completely than ground grain. Soaking either the whole or ground grain does not increase its feeding value. For hogs, the Kansas Station has found it advisable to put the dry ground grain in the trough and pour water over it.

Kafir corn fodder without the grain much resembles cornstalk fodder after the ears have been removed. It is used as a coarse fodder in the same way. As a hay crop it is hardly as valuable as some of the sweet sorghums. It is not so palatable and the yield is lighter. Grown for hay 1½ to 2 bushels of seed per acre sown broadcast are used and the crop cut when the seed is in the dough stage.



DROUTH RESISTANT ATLAS SORGO

Milo has compact bearded heads, juicy stalks and large yellow or white seeds. It is highly susceptible to injury from chinch bugs and to root rot. Milo is more resistant to drouth than Kafir corn and produces very heavily under favorable moisture conditions.

Among the many other forms of grain sorghum cultivated to some extent in Texas, Oklahoma, California and elsewhere, mention should be made of Kaoliang, Darso, Hegari and Freed. Kaoliang came from China and Manchuria where it is widely cultivated. All varieties of Kaoliang mature early and may be grown farther north in the United States than any other grain sorghum. Sparseness of leaves makes the crop of little value as fodder. In China the stalks are used as fuel and as reinforcement rods in building adobe walls.

Sorgo is the name recently adopted for the sweet sorghum from which sorghum sirup is made. About 15,000,000 gallons of this product are produced annually, mostly in the Southern States and California. The stage of sorgo at which the best sirup will be obtained is when the seed is in the soft or medium dough condition according to C. F. Walton, Jr. Cutting is done by hand or by a harvesting machine. The leaves are stripped off and 2 or 3 of the top joints lopped off and the lowest joint left standing. The yield of the green crop ranges from 4 to 15 tons an acre. A ton of sorgo produces 8 to 20 gallons of sirup, depending on the sugar content of the juice.

As a Sugar Plant. The production of sugar from sorghum has not yet assumed extended commercial importance owing to the difficulty thus far experienced in securing profitable amounts of crystallizable sugar. No trouble is experienced in making a good quality of sirup and considerable amounts of sorghum are grown for this purpose. When sorghum is grown for sirup or sugar, good corn or

wheat lands are fitted as for corn. The seed may be sown either in hills or drills. On weedy land hill culture is advisable, since cultivation can then be practiced both ways. The hills should be about 3½ feet apart each way. From 20 to 25 seed should be dropped in each hill and covered 1 to 3 inches deep, depending on the dryness and lightness of the soil. When the plants get well up they should be thinned to 6 or 7 stalks in each hill. A large amount of seed is necessary, since some of it is likely to rot or fail to germinate.

If sown in drills the rows should be about 3½ feet apart and the plants 6 to 7 inches in the row. Sorghum should not be planted until after the ground gets thoroughly warmed up, generally not till the latter part of May or in June, after the corn is planted. It grows very slowly at first while it is making a root system, and weeds, if allowed to get a start, will quickly smother it. Frequent shallow cultivation should be given throughout the growing season and the suckers kept removed. The canes should be cut when the seed is in the hard dough stage. When grown for molasses the cane is stripped of its leaves and topped by hand. It should be cut and taken to the mill as soon as stripped. For this purpose it is usually tied in bundles about 8 inches in diameter. If these cannot be immediately worked up they should be piled in layers crosswise to admit of a free circulation of air. Frost injures the quality of the cane and the crop should be harvested before frosts come. At the sugar mills the cane is usually cut up into small pieces with the leaves on and the leaves afterward removed with a fanning mill.

As a Forage Plant. Sorghum is regarded as one of the most valuable forage crops. It is especially valuable for the drier portion of the South and for much of the semi-arid West and Southwest. Sorghum is a stronger feeding plant than corn and will do better on thin lands. Its roots feed deeper in the soil and the plant withstands drouth and alkali better. Seed broadcast or with a press drill after the soil becomes well warmed up at the rate of 1½ to 2 bushels per acre. Cultivate the seed in. A disc harrow has proved valuable for this purpose on dry, sandy soils. A better forage will be obtained if some plant like peas is seeded with the sorghum. In such cases 3 pecks to 1 bushel of each should be sown per acre. Good results are also obtained by seeding with a common seed drill.

One difficulty in sorghum growing is the trouble from weeds. If the ground is weedy at the time of planting, the slow-starting sorghum is likely to be overtaken and smothered. In such cases cultivation with the harrow should begin while the weeds are small. The seedbed should be freshly harrowed just before the seed is sown in order to destroy all germinating weeds.

Sorghum grown for hay should be cut when the heads are well formed, and the seed about half ripened. It may be cut with a mower, corn harvester, knife or binder, and shocked like corn. The usual method of cutting is with a mower. The sorghum is then left to lie on the ground a few days to dry out. If the crop is heavy it should be turned over so that the bottom part of the stalks is exposed to the sun. When well dried the sorghum is raked into good sized cocks. The crop may be fed directly from the cocks, or these may be allowed to stand a few days to undergo sweating and fermentation, then opened to the sun for a few hours and hauled to the barn or put in larger stacks. Sorghum does not keep long unless well cured and should be fed out during the fall and early winter.

Sorghum yields from 3 to 15 tons of cured forage per acre. When cut but once a yield of 5 to 10 tons may be expected on good soils. If 2 or more cuttings are obtained the yield sometimes runs up to 12 to 15 tons per acre. In general about a third heavier yield may be expected than with corn on the same soil.

Uses. Sorghum has a high value as a soiling crop. It is especially valuable for dairy cows and for fattening animals. It can be had in July, August and September, just when pastures are failing. Care should be observed to give the animals only a small amount at first until they grow accustomed to it. A light feed of grain or other food should be given first.

As a summer pasture sorghum is especially relished by sheep, cattle and hogs. For this purpose it should be sown or drilled thickly and several sowings made at different dates in order to secure a succession. It is the custom of many farmers to cut the first crop for hay and then pasture the field afterward with stock. Before cattle or sheep are turned on sorghum pasture they should be pastured on grass or given some dry feed and not turned into the field until the dew is off. Fatal results sometimes occur when cattle are allowed to eat freely of green sor-

ghum. Under certain conditions prussic acid is formed in sorghum. Experiments at the Nebraska Station indicate that the most pasturage on sorghum is obtained when the stalks have reached full height, but before the heads have formed.

Dry sorghum forage is fed like cornstalks in racks. It is more readily eaten by all stock than corn fodder, and there is much less waste in feeding it. Some sorghum silage has been made, but it is more difficult to keep in good condition than corn, and where corn can be obtained it is the better silage plant of the two.

Sorghum seed is somewhat similar in composition to corn, but is not so valuable for general feeding purposes. It is generally fed on the stalks with the forage. The seed should be ground. It is considered to be 90 per cent as valuable as corn. It is best to feed with wheat, bran, oats or peas.

SOY BEAN

The triumphant spread of the soy bean from China, where it has been cultivated for more than 4000 years, to the farm lands of Asia, Europe, Africa, and the islands of the seven seas, arriving finally in Pennsylvania in the early 1800s, is one of the many romances of agriculture. Even the casual traveler in China and Manchuria has forced upon his attention the stupendous importance of this crop to the Chinese. Boiled, roasted, baked and served in scores of styles, as vegetable milk, cheese, and "meat" cakes, and in mixtures beyond number, it has been the staff of Chinese life for 40 centuries. It helps to explain the great sturdiness and endurance of the Chinese race. Modern chemists have found that, along with peanuts, it furnishes the most complete and efficient protein of all the legumes. No wonder that it was held as one of the sacred grains and that emperors presided over the ceremony of the spring sowing in a religious rite resembling that of the Siamese with rice, and of the Maya Indians with corn.

Illinois is our banner soy state with more than half the total to her credit, but the U.S. soy area has reached about 7 million acres and nearly 60 million bushels of seed. About 70 per cent of the acreage is found in Illinois, Indiana, Iowa, Ohio and Missouri. But it thrives everywhere

SOY BEANS AND CORN MIXTURE

east of the Mississippi except in the extreme north, according to the Department of Agriculture.

The soy bean is an annual bushy legume reaching a height of 1 to 4 feet and resembling the common navy bean in its early stages. The leaves and seed pods are borne on the 5 or 6 branches of the main stem. The beans, 2 to 4 to a pod, are light yellow, green, brown or black according to variety. In general soy beans ask for about the same soil and climatic conditions as corn, taking kindly to the northern half of the cotton belt and the southern half of the corn belt. Farther west the lack of moisture limits the crop. In eastern Nebraska the soy bean has given a good account of itself, and has also been grown under irrigation. It is immune to the attacks of chinch bugs which wreak havoc with cereal grains, but the crop may suffer badly from rabbits and grasshoppers. Alfalfa and clover in Nebraska have a more beneficial effect on succeeding crops, at least in years of abundant rainfall, than do soy beans.

The varieties of soy beans are legion, and new forms are constantly being put upon the market. In choosing a variety the beginner in soy production must rely on the advice of experienced growers in the neighborhood. The Department of Agriculture has tested 2500 types varying in shape, height, color, composition, and in time of maturity from 75 to 200 days. The experiment station in each State is best able to recommend varieties for any particular area of the State.

It seems hardly necessary to repeat that the details of thorough seed bed preparation are as important for success with soy beans as with other farm crops. Christ's parable of the sower should be enough to hint that seed are likely to germinate and produce only when placed where they find suitable conditions for growth. Inoculation with the special bacterial cultures which produce nitrogen nodules on soy bean roots is helpful where the crop is sown for the first time. Experiments in Kansas and other States have shown that soils on which soy beans do not form root tubercles may be successfully inoculated by sowing in the drill with the beans 1000 pounds per acre of dry soil taken from fields in which soy beans with root tubercles have been grown. A field once inoculated apparently remains so permanently.

The time of seeding may vary from early spring to midsummer depending upon the latitude and the purpose for which the crop is raised.

Planting and Cultivation. The soy bean is a warm weather plant and should not be sown until the soil becomes well warmed up in May or June. It is frequently sown after a rye or barley crop is taken off and a good growth of forage secured, or even of seed if early maturing varieties are grown. As a rule the beans should not be put in the ground until after corn is planted. The station experiments show that the best results are obtained with soy beans when they are seeded in rows from 24 to 40 inches apart at the rate of 10 to 75 pounds per acre, and level culture practiced. A common grain drill may be used for this purpose if some of the holes are stopped up to make the right spacing between the rows. The machine should drop 6 or 7 seeds to each foot of row. The field should be cultivated shallow soon after the plants are up to keep down the weeds, and for a few times after rains to break up the crust that forms. Soy beans do not require as much cultivation as corn. As with field beans, cultivation should not be given when the plants are wet from rain or dew.

For seed production planting in rows to be cultivated as for corn gives best returns. But for hay, green manuring or soiling the seed may be sown in close drills. A better quality of soy bean hay is thus obtained and the tonnage of green crop is greatly increased. The Department of Agriculture advises that if soy beans are to be seeded with corn for pasture or silage, the beans may be planted in the same hills with the corn, or in alternate hills or in alternate rows. The kind of soil determines the right depth of seeding, in heavy clay soils not over one inch deep, and in loams or sandy soils up to 3 inches. If a crust forms on the soil before the young plants appear, light cultivation with a rotary hoe may be required. In any case weeds must be kept down by cultivation between the rows till the plants are well along, and in drilled plantings treatment with a weeder may be needed until the beans are 6 inches high.

Soy beans fit into a considerable variety of rotation systems. In Louisiana, where the beans are grown in rotation with rice, beneficial effects are seen in the reduction of the weed pests. Corn, soy beans, wheat and clover constitute a common rotation north of the Ohio River. Many farmers grow soy beans in mixtures with other

crops such as cowpeas, Sudan grass, millet, sorghum, etc.

Harvesting. Soy beans grown for soiling purposes may be cut from the time the plants come into bloom until the pods begin to ripen. For hay of the best quality the crop should be cut when in full bloom and the pods beginning to form. For silage it should be cut when the pods are well formed and the seed three-fourths grown. For seed the crop should be cut when the pods have turned brown, but before they are fully ripe; if too ripe the pods will burst open and scatter the seeds.

The crop may be cut with a scythe, mower or regular bean harvester or pulled by hand. At the Kansas Station the crop was cut by removing the shovels from a double shovel cultivator and bolting knives 18 inches long which set out from the cultivator and sloped back somewhat. With this arrangement 2 rows can be cut at once, the knives cutting off the plants just at the surface of the ground. When more than 10 acres are grown, the Kansas Station recommends the use of a regular bean harvester. When the crop is grown for seed the plants are cut off, raked together in windrows and allowed to dry out a little, then stored or stacked in a dry place. For hay the crop in moist climates should be allowed to wilt and dry out somewhat in the swath, and then put in small, loose piles to cure, and handled like clover hay.

The yield of green soy bean forage at the Connecticut Station on fairly good manured land was 10.3 tons per acre. This was about ⅓ less than corn on the same land. Yields of 15 tons per acre have been reported. At the Massachusetts Hatch Station yields of 25 to 40 bushels of dry beans per acre are reported. Yields of from 15 to 20 bushels per acre are reported by the Connecticut Storrs Station, while the average yield at the Kansas Station under field conditions was 13 bushels per acre and the cost 40 to 50 cents per bushel for growing. Threshing is done with a common threshing machine by taking out the concaves, or by pounding out with a flail.

Uses. The dry beans are a highly nutrious feeding stuff and rank with linseed meal, gluten meal and cottonseed meal in feeding value for steers, dairy cows, calves, hogs and other stock. The meal has the same laxative effect as linseed meal, and when fed to dairy cows tends to soften the butter. At the Kansas Station 30 per cent better gains were made when soy bean meal constituted a part of the grain ration fed to hogs than when Kafir corn or corn meal was fed alone. The beans may be fed to hogs whole or ground or unthreshed on the stalks. If ground and fed with Kafir corn they should be mixed and wet just before feeding. Soy beans are too rich in protein (muscle and blood-making material) to be fed as the whole grain ration to animals. Better results will be obtained when it is fed with some more starchy grains that produce fat, like corn and Kafir corn. Three or 4 pounds of the meal added to the grain ration for dairy cows is advisable.

As a soiling crop for dairy cows soy beans have given excellent results from the standpoint of milk and butter production. They are especially valuable when mixed with such crops as corn and sorghum. The silage made from soy beans is very satisfactory. The late varieties yield heavily; the crop is easily ensiled, and the quality of the silage is even more satisfactory than soy bean hay and considerably more economical to make. The Connecticut Storrs Station recommends that the crop be ensiled with corn, putting the two down in alternate layers. This makes a more balanced ration than either alone. Soy beans are often pastured in the South with hogs, and the results have been very satisfactory. As a soil renovator soy beans rank close to red clover, but hardly equal that plant. For feeding experiments with soy beans see under each of the different farm animals, particularly swine.

In Illinois it has been found best to harvest soy beans for seed with a combine because this method saves more seed than the binder-thresher system and requires less labor.

Several insect pests attack soy beans more or less seriously. Grasshoppers are most injurious in semi-arid climates. They may be controlled by scattering broadcast the familiar poison bran bait at the rate of 8 to 10 pounds per acre. Leafhoppers, blister beetles, velvet bean caterpillar, clover worm and other insects as well as bacterial blight and a considerable list of diseases may cause damage to soy beans. Remedies for these troubles are under constant study and are being currently improved by the entomologists and plant pathologists at the State Experiment Stations. They may best be consulted when insect pests or diseases appear. On all these occasions it may require such a qualified specialist to pro-

perly diagnose the trouble and prescribe the effective remedy.

SUGAR BEET

Back in the early 1800s France was threatened with a shortage of sugar by restrictions on the shipment of sugar cane from the West Indies. What other source of sugar could replace cane? Napoleon ordered the nation's chemists and plant breeders to find the answer. Starting with the common garden beet, a native of the Mediterranean region, and ordinarily possessed of a sugar content of 3 to 5 per cent or more, they bred up a strain of beets with a sugar content of 12 to 20 per cent, with the result that today in a total world production of 33½ million tons of sugar, 11 million tons come from sugar beets. Of the 2 million tons of sugar produced in continental U.S. all but about 420,000 tons come from sugar beets. The chief producing States are California, Colorado, Michigan, Nebraska, Idaho, Montana, Wyoming, Utah and Ohio.

SUGAR BEETS IN COLORADO

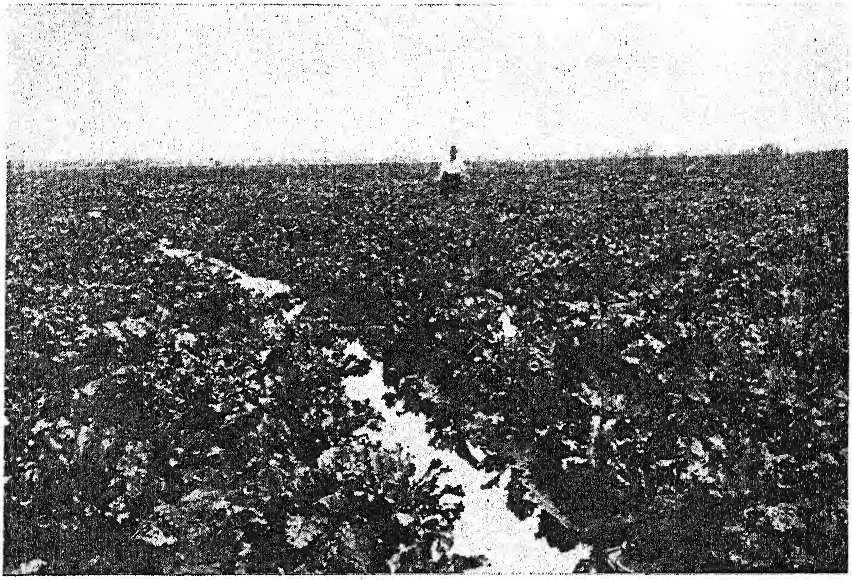
Cane sugar and beet sugar are chemically identical in composition and of the same sweetening power. The sugar beet has been under intensive study in the U.S. for the past 50 years. Since most of the sugar required to satisfy the nation's sweet tooth came from Hawaii, Porto Rico, The Philippines, Virgin Islands and Cuba, and as we had only a small area, mostly in Louisiana, suitable for sugar cane, it seemed very important to promote the sugar beet industry. In this work the United States Department of Agriculture and the State Experiment Stations have taken a leading part. Vast quantities of beet seed have been distributed to farmers in all parts of the country, and hundreds of thousands of bulletins and pamphlets containing cultural directions and general information regarding sugar beets have been sent free to growers in every State. The beets grown have been analyzed, the cultural data obtained digested and the results published broadcast. As a result of all this work it has been definitely established that sugar beets can be successfully grown for sugar production in those portions of the United States which have a mean summer temperature of 70 degrees F.

Factories. The manufacture of beet sugar cannot be done on a small scale by farmers, as is the case with sorghum and cane. "The juices of the beet are extracted with difficulty. They contain large quantities of mineral salts which render the crude sugar and molasses made therefrom bitter and unpalatable. The refining of the sugar is a process which requires an extensive outlay for machinery and a high degree of supervisory skill. It cannot, therefore, be accomplished on the farm." The farmer is concerned primarily with the growing and marketing of the beets; the manu-

facture of the sugar is an industry entirely distinct from agriculture.

The cost of erecting a factory capable of using 300 tons of beets per day is about $250,000, and experience has shown that smaller factories are not profitable. The conditions affecting the establishment of a factory in any neighborhood after it has been determined by trial that sugar beets of good quality can be grown there are: (1) Suitable transportation facilities for both the raw beets and the refined sugar; (2) guaranty of the production of a sufficient quantity of beets for a good campaign; (3) abundant supply of pure water; (4) a daily supply of 50 tons of coal or its equivalent in wood, and of 20 tons of lime rock; (5) competent labor at reasonable prices and (6) economic methods of handling the pulp either by feeding to stock or preparing for market.

Sugar beets do best in regions lying between the isotherms of 67 degrees and 72 degrees mean temperature May to September inclusive, and most beet sugar factories are located within those areas. Warm days and cool nights are prerequisites to high sugar production. Too rapid and too rank vegetative growth may check the storage of sugar in the roots, while cool nights at the end of the season hasten the production of sugar. But results are obtained only where this process goes on uniformly, and that in turn demands pretty uniform moisture conditions in the soil.



IRRIGATING SUGAR BEETS

Soils. The work of the experiment stations has shown that the heaviest yields of sugar beets and beets containing the highest percentage of sugar in the juice are produced on rather heavy, well-drained and fertile clay loam soils. When possible loam soils should always be selected for sugar beets. On the lighter, sandier soils the beets will mature earlier, but the yield of both beets and sugar per acre will be less than on the heavier soils. Sugar beets on muck soils have generally given good yields, but the amount of sugar contained in the juice has been so low as to make their culture on such soils unprofitable. Hard clay soils should never be selected for sugar beets. On these soils the roots are unable to penetrate deeply and much of the beet grows above the ground. This portion has to be cut away in topping, occasioning a large loss in the yield of sugar. Heavy yields of sugar beets and beets of excellent quality have been grown on many of the alkali soils of the West. According to the Colorado Station sugar beets containing a high sugar content and percentage purity have been grown on soils showing a top incrustation of soluble salts ½ inch thick. Good beets have also been grown

in alkali soils in California, New Mexico, Utah and Wyoming.

In Nebraska, Wyoming and South Dakota where the rainfall varies from 6 to 20 inches, and where the precipitation is made up of scattered light showers, irrigation is required. As stated by S. B. Nickols, farmers usually disregard the irregular rainfall of July, August and September and apply water at regular intervals, the number of irrigations varying from 3 to 7 per season. Unequal distribution of water over the field is one of the common mistakes in irrigation practice. If the furrows are too far apart or too long it is difficult or impossible to spread the water evenly. When rainfall is deficient at the time of planting the grower must resort to the method of "irrigating up" as the popular phrase has it, by applying water within 24 hours after planting in order to hasten germination of the seed. Regular irrigations usually begin in the 3 States under consideration, from June 20 to July 5 and are followed by further applications at intervals of 2 weeks, the final watering being given not later than September 15. If the leaves begin to turn dark green or fail to recover from the noonday wilting, water must be applied at once. Sugar storage in the root takes place rather rapidly after August, when it may amount to only 8 per cent, till October and November at harvest time, when it usually reaches 15 to 18 per cent or more.

In the Utah-Idaho area, where the average annual rainfall is less than 14 inches, the streams from which water is taken have a heavy flow early in the year when the snow in the mountains is rapidly melting. By midsummer the volume of these streams diminishes. Since sugar beets need water later in the season it is necessary to depend upon storage reservoirs or thorough soaking of the soil while the water is abundant. As in other irrigated regions, light, frequent applications of 2 or 3 inches are better than heavy flooding at longer intervals.

Rotation practice varies greatly according to soil and local conditions. Rotations of from 4 to 10 years in length have been devised in which the crops are arranged in different sequences but usually include alfalfa, clover, beans, potatoes or small grain. Commercial fertilizers are little used in this area but barnyard manure is highly thought of for sugar beets, while alfalfa and sweet clover are the principal green manure crops. Recently Colorado and Nebraska have been turning more and more to green manuring.

Ordinarily the time of harvesting is determined by the chemists of the mill company who make tests of the sugar content and purity of the juice as a guide to the start of the harvest. As described by Nickols: "Beets are lifted by a double-pointer puller which lifts and loosens them from the soil. The proper adjustment of the beet puller is very important. A poorly adjusted puller leaves a portion of the beets in the ground or breaks off the roots. These losses sometimes amount to a ton or more of beets per acre. Old and worn puller points often cause a puller to tilt behind and break off the roots of many of the beets.

"Careful topping is very essential. The beets should be topped in a manner that meets the requirements of the receiving company. It is usually specified in the grower's contract that the beets shall be topped at right angles to the long axis of the beet and at a point indicated by the lowest leaf scar. To top lower than this reduces the tonnage. To top higher than this is useless, as the receiving company samples and tares the beets and deducts from the weight an amount estimated to be the excess crowns left on the beets.

"In some areas the toppers pile the beets and top them from the piles. The piling reduces the dirt tare, as the double handling shakes more off the roots. In other areas the toppers use a knife with a hook attached to the point and top the beets from the row at one operation. The hooks on the knives permit of more rapid topping, but are objected to in some areas since the wounds caused by the hooks are often the starting point for storage rots. A smooth spot should be prepared for piling the beets in the field. In this manner the beets are easier to load and less dirt is thrown into the wagon and hauled to and from the receiving station.

"Dirt returned to the grower at the receiving station should not be dumped in the field because of the danger of introducing nematodes in this way. The machinery of the receiving station cannot be cleaned sufficiently to prevent a slight carry-over of dirt from one load to another, and many cases of field infestation with nematodes are traceable to the dirt brought back to the field from the sugar beet dump. Beets should be hauled immediately after digging, unless they are sufficiently covered with tops or soil to prevent drying or freezing."

The beet tops left in the field are val-

uable feed and are commonly utilized by turning stock into the field after harvesting. An acre of beet tops is rated equal to 1 ton of alfalfa hay, the weight of an acre of tops ranging from 3 to 8 tons. Beet pulp, the by-product resulting from the extraction of the juice at the mills, is also an excellent feed and is to be had either fresh, siloed, dried or pressed. Young feeder cattle and dairy cows relish this product. Beet molasses contains about 5 per cent of potash and is too laxative for feeding in large rations but is extremely valuable when added to beet pulp or alfalfa hay in daily amounts of 3 to 5 pounds of molasses per 1000 pounds of live weight of farm stock.

Sugar beet culture has always entailed a great deal of hand labor, especially during the thinning, hoeing and harvesting seasons. Part of the thinning operation has been mechanized but it is still necessary to hire contract labor in crews for the rush season. For this purpose large numbers of Mexican and Japanese laborers have been used in the chief sugar beet areas from Michigan to California.

Until 1932 nearly all the sugar beet seed used in U.S. was imported from Europe, but domestic production of seed has been developed in Arizona, New Mexico, California, Oregon and other States to a volume of over 12,000,000 pounds a year.

Sugar beets are subject to the attacks of several diseases and insect troubles. The most important leaf disease of the sugar beet in the humid area is leaf spot, caused by the fungus *Cercospora beticola*. This disease is characterized by small circular spots, on the leaf blades. Under conditions of severe attack, the spots on leaf blade or petiole coalesce, and as a result of the combined effect of the spotting and leaf-vein injury, severely affected leaves turn brown and die. The attack may be so severe that the entire field takes on a scorched appearance, commonly referred to as blight. The disease starts on the older leaves and advances to the younger leaves as they develop. The fungus may occur on beet seed and in this way be introduced into the field each year. Probably only a plant here and there in the field becomes diseased from this source of infection. It has been shown that the fungus can live over on dried tops at least 3 years. Where beets follow beets too closely in the rotation, the young plants are exposed not only to the infection of seed origin but to the more extensive infection which comes from the diseased leaves of a previous beet crop. Seed treatment has not been effective in control of cercospora

SUGAR BEET SEED FIELD

leaf spot. Application of Bordeaux mixture or the dusting with copper fungicides is effective for leaf spot control. At least 3 or 4 applications, begun early in the season, are required. In areas where the disease does damage nearly every year, such protective measures would be warranted and would show definite gains. An essential for control of sugar-beet leaf spot is close adherence to a rotation system in which sugar beets do not follow sugar beets, and in general at least 3 years intervene between sugar beet crops.

As recommended by J. G. Lill, careful drainage of the soil to prevent water logging, and the observance of suitable rotations, are helpful in preventing the occurrence of seedling diseases such as black root and damping off. Attention to the phosphate requirements of sugar beets is distinctly beneficial in rendering beet plants more resistant to root rot. Seemingly, also, that disease is less frequent in fields where beets follow corn than where they follow legumes.

Among the insect enemies of sugar beets perhaps the most serious are grasshoppers, wire worms, white grubs, flea beetles and cut worms. Cut worms are readily controlled by the use of poisoned bran. Wire worms and white grubs pass through a larval stage of 3 or 4 years mostly in sod land. It seems wise, therefore, to avoid following sod land directly with beets but to plant beets on land which was in some cultivated crop the previous year, and to practice fall plowing wherever possible.

SUGAR CANE (*Saccharum officinarum*)

Sugar cane is a tall rank growing perennial grass with bushy, graceful tassels, and attaining a height of 6 to 15 feet or more. It is a native of India, Malaya and Cochin China, and is now cultivated throughout the tropics and subtropics. The roots of sugar cane are delicate and fibrous, varying in length from 18 inches to 10 feet; the leaves are 2-4 feet in length and 2 or 3 inches wide. Sugar cane is raised in the U.S. from Texas to South Carolina, but in 8 of these States it is raised only for sirup, while sugar is refined from it in Louisiana and Florida. In tropical countries cane requires 12 or 14 to 18 months or more to mature. On account of the cool winter weather in Louisiana cane must be harvested in an immature condition. The juice is therefore impure, containing a high amount of reducing sugar, and being relatively low in sucrose. In Louisiana the harvesting season extends from October to January.

Soils. Sugar cane flourishes on rich alluvial bottom lands, but may be grown on any fertile soil in warm climates where water is abundant and the soil is well drained and well tilled. The sugar soils

SUGAR CANE IN SOUTH CAROLINA

of Louisiana range from loamy silts to almost pure clays. This makes good drainage absolutely essential in that State. The Station recommends open drains every 100 feet apart and deep enough to hold the ground water at least 3 feet below the surface soil.

Preparation and Planting. A somewhat systematic rotation is adopted in growing sugar cane in Louisiana and consists of corn, cowpeas and cane. Corn is planted early in the season and cultivation stopped early. At the last cultivation cowpeas are sown between the rows. The corn is gathered early and the cowpeas turned under in August or September. At this time the soil is deeply plowed and thrown into beds or rows 5 to 7 feet wide. After the ground has been put in fine tilth by cultivation the ridges of the rows are furrowed out and the cane planted. Sometimes only 1 continuous line of canes is placed in the bottom of the furrow, but 2 lines have given the best results in the station experiments and are recommended. The canes are covered by a plow, harrow or by hand. When 2 canes are laid side by side in 7 foot rows it requires 4 tons of cane to plant an acre. The use of the upper third of the stalk for seed has given excellent results at the Louisiana Station. As this portion is less rich in sugar than the other parts of the stalk its more general use has been urged.

Planting may be done either in the fall, early winter or spring. Late fall or early winter planting causes an earlier spring growth and is generally preferred in Louisiana. In Florida spring planting is generally practiced. The rows are made from 5 to 7 feet apart. In Florida rows 5 feet apart are recommended. After planting the middles of the rows are plowed out to secure better drainage and the soil in cultivation thrown toward the canes. Shallow, clean cultivation till June has given best results. The buried canes throw out plants at the nodes of the stalk, so that stalks every 6 to 12 inches in the row are obtained. A field once planted to cane may last for many years, depending on the climate, soil, etc. This is true of the fields in Cuba, Hawaii and many other tropical countries. In Louisiana the cane fields are maintained from 1 to 3 years. The canes that grow the first year after planting are referred to as plant cane; those that grow from stubble are first-year stubble, second year stubble, etc.

Fertilizing. Nitrogen and phosphoric acid are the chief fertilizing elements needed in Louisiana soils for sugar cane. The nitrogen is largely supplied by turning under a crop of cowpeas every third year. An excess of nitrogen may decrease the sugar content. Phosphoric acid may be applied in the form of dissolved bone, Thomas slag or acid phosphate. The last is considered the best. About 800 pounds, analyzing 12.5 per cent available phosphoric acid, should be applied per acre. On sandy loam soils where potash is needed about 100 pounds of the muriate will usually be found sufficient.

In Louisiana on the western prairie edge of the sugar belt, rice is a possible competitor with cane, and on the northern border cotton is a rival. But on the sugar lands along the waterways from Baton Rouge to New Orleans no one has found a more profitable crop than sugar. Yet production is not increasing in that area, and some of the growers have indicated that unless the tariff on sugar is raised there will be little inducement toward expanding the sugar area.

Harvesting. Sugar cane is crushed for sugar in November and December. The leaves are first stripped off in the field and 1 or 2 of the upper joints removed. The crop should be harvested before frosts come. After a splitting freeze the crop should be worked up as rapidly as possible. Some protection is afforded the canes when frost threatens if they are thrown in windrows so that the tops cover the power parts of the canes in front of them. This method is also recommended when cane is kept over till spring for seed. They should be covered by turning a couple of furrows over them. The yield of sugar cane varies from 10 to 40 tons per acre, and the amount of sugar in a ton of cane from 125 to 300 pounds, besides a considerable amount of molasses. At the Louisiana Station yields of 30 to 40 tons of cane are reported per acre.

Sugar Making. Cane sugar may be manufactured on a small scale and with comparatively simple machinery; but for economical production and sugar of the best quality an extensive plant is necessary. On a small scale the cane is crushed by some form of roller, the juice brought in contact with sulphur fumes, then neutralized with lime and boiled down to a thick syrup. Stirring the syrup induces graining. The grained sugar is separated from the syrup by allowing the syrup to drip or drain into another vessel.

Varieties. The chief varieties of cane grown in Louisiana are the purple and striped or red ribbon cane. The Station tests showed these to be about equally valuable. A seedling variety known as No. 74 has also given excellent results in the Station tests. It is a dull green cane with long joints. It yielded 38 tons of cane and the juice contained 16 per cent of sugar. In Florida the station states that red cane is hardier than green and matures earlier, and that for large areas and for sugar the red variety is best, while for small areas and syrup the green cane is preferred. A foreign variety known as Japanese is quite resistant to cold and is recommended for those regions just north of the cane belt.

Enemies. Sugar cane is attacked by a number of fungus diseases and by the cane borer and other insects. But little work has been done along this line in the United States. Some of the fungus diseases are carried from plant to plant by the insect pests of sugar. In order to prevent the undue multiplication of the latter, special care should be exercised in giving clean cultivation and in destroying all diseased plants and rubbish in the sugar cane fields.

SUNFLOWER (*Helianthus annuus*)

The native American plant, from which our cultivated sunflower was derived, at the time of the advent of the white man was found growing from the Mississippi westward and from Minnesota to Mexico. Along river banks this wild plant reaches a height of 8 to 10 feet while on the dry plains it is of more modest habit. Ordinarily it is not highly thought of, being one of the most maddening and ubiquitous weeds in corn fields from Texas to North Dakota. The seeds are roasted and tried as a substitute for coffee, and during the worst drouth years of the "dust bowl" the plant was used for silage. The Indians made a hair oil from the seed after some anonymous Indian plant breeder had developed a strain with large seeds. Then some seed was taken to Spain whence the plant spread to other parts of Europe and finally to Russia where the wild plant of our Great Plains received the earnest attention which resulted in the development of the familiar plant with the large heads 8 to 20 inches in diameter. It was then brought back home under the name Mammoth Russian sunflower.

It grows freely from Canada to Mexico. The seed is used for feeding to birds and poultry and to some extent for medicinal purposes to horses and cattle. The silage mixture known as Robertson's mixture is a mixture of sunflower heads, horse beans and corn in the proportion of 2 acres corn and beans to ½ acre of sunflowers. In Russia the oil of the sunflower seed is used for the same purposes as olive oil. The seed is also eaten raw and roasted like peanuts.

Sunflowers grow best, according to the Department of Agriculture, for commercial purposes in Kansas, Missouri and the Ohio valley, though many other sections of the country are well suited to the growth of sunflowers. The soil required for the crop is about the same as best suits Indian corn. If it is not fertile, liberal manuring must be practiced. In California sunflowers have done well on alkali soils.

Planting and Cultivation. Prepare the land as for corn. Plant the seed 2 to 3 inches deep in drills about 3½ feet apart, using 10 to 15 pounds of seed per acre. When the plants are about 8 inches high thin to stand 12 to 18 inches distant in the row. The plants are not injured by slight frosts and may be seeded before the corn crop is put in. This gives the heads time to mature before the early frosts of fall. The crop should be given shallow, level cultivation the same as corn. It withstands drouth well and is remarkably free from insect pests and fungus diseases. When the plants are in bloom the field should be gone over and the excess bloom pulled off, leaving only 3 or 4 heads to develop.

Harvesting. The sunflower heads should be harvested before the seed is quite ripe in order to avoid shattering. When the heads have thoroughly dried the seed may be beaten out with a flail or some simple apparatus. No special machinery has yet been put upon the market for this work. The seed should be stored in small bins, barrels, etc., to avoid heating. The yield of seed varies from 800 to 1000 pounds per acre and the price from 2 to 3 cents per pound. A bushel varies in weight from 25 to 35 pounds, averaging about 30 pounds. The seed yields from 15 to 20 per cent of oil by cold pressure.

Uses. The use of the seed as a bird and poultry food and its value for oil production has been noted above. Results obtained in growing this crop for silage in Maine and Vermont show that in these sections it has no advantages over corn. At the Maine Station the stems of the plant were also ensiled and

rendered palatable by this treatment. The yield of green matter has been from 11,000 to 12,000 pounds per acre, containing from 2000 to 2700 pounds of dry matter. At the Canada Stations the butter made when a silage mixture containing sunflower heads was fed was of a richer flavor and higher color than where corn silage alone was fed.

Robertson Mixture. The Robertson ensilage mixture is made by growing together a mixture of horse beans and corn planted in drills at the rate of about 4 seeds per foot or in hills 3 feet apart each way, putting 6 to 10 seeds in each hill. Two acres of this mixture is put in the silo with ½ acre of sunflower heads, cutting both together. The corn and beans are cut when the corn in the ear is beginning to glaze. 50 pounds of this mixture should be fed with 4 pounds less grain than is ordinarily given when corn silage is fed.

It has been found that about 72 bushels of seed per acre may be reasonably expected. The oil is yellowish or almost colorless, may be used for all culinary purposes in place of olive oil, is as near odorless and tasteless as a vegetable oil may be and will not turn rancid within a year or more at ordinary temperatures. Considerable sunflower oil was recently produced in Cuba. California, Missouri and Illinois are our chief producing States with a total output of 7½ million tons of seed.

SWEET CLOVER (*Melilotus alba*)

Sweet Clover is a legume which has come to be properly appreciated for its several virtues only during the past 20 years. Long regarded merely as a vigorous and interesting roadside weed with a characteristic aroma and high honey-producing quality, it has lately become a prominent rival of even alfalfa and red clover in the corn belt for hay, mixed cultivated pasture, for green forage, as a soil renovator and in a large variety of farm rotations.

White sweet clover, also called Bokhara clover or melilotus, grows to a height of 3 to 8 feet or more, bears a profusion of leaves resembling those of alfalfa, and numerous graceful spikes of small, white sweet-scented flowers. It does particularly well on calcareous soils, but makes a fairly rank growth even on the poorest soils where most other legumes would fail. One of the familiar sights in extensive real estate developments around cities, where large leveling operations have been

SWEET CLOVER IN NEW YORK

carried on, is the promising crop of volunteer sweet clover even on gravelly subsoil which had originally been 10 feet or more below the surface.

According to reports from the corn belt States, lime is, perhaps, the most needed element in soils for success with sweet clover. In the corn belt the crop is seeded in the spring with oats, barley, or flax, or in winter wheat. Occasionally it is seeded alone or with corn, but without much success. For seeding with spring grain a grass-seeder attachment on the drill serves the purpose. For seeding on winter wheat the usual practice is to broadcast sweet clover seed on the fields sometime between January and March.

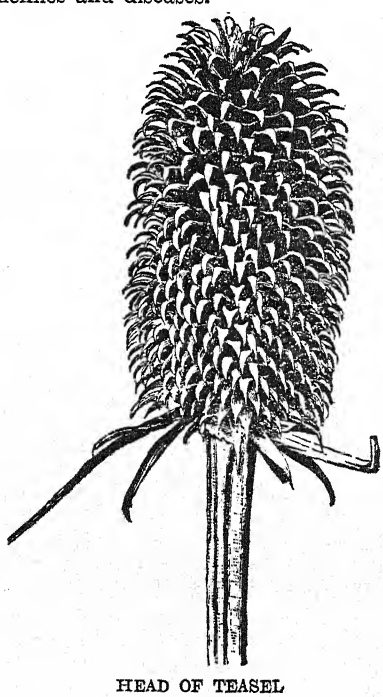
As a soil improver sweet clover stands without an equal. The Department of Agriculture obtained reports from 63 farms on which careful records were kept of the effect upon the yield of corn from plowing under a previous crop of sweet clover. The yield of corn following a previous crop of corn or small grain was 31 bushels per acre as compared with 51 bushels where sweet clover had been plowed under. In Indiana a sweet clover intercrop used as green manuring for corn produced a 9-bushel per acre increase. The same land seeded to oats the following year produced 98 bushels per acre as compared with 50 on land where no sweet clover had been plowed under to benefit the previous corn crop.

As a green soiling crop sweet clover has yielded equally good results. In South Dakota the green plants were cut as soon as they reached a height of 12 to 15 inches and hauled at once to the feed lot for dairy cows. Excellent milk yields were maintained and the crop provided twice as much feed per acre by that method as from pasturing it.

As pasture for dairy cows, beef cattle, calves, hogs and sheep flattering reports on the value of sweet clover came in from all quarters. The plant is known to cause bloat in cattle and sheep but is less likely to do so than is red or alsike clover or alfalfa. Bloating occurs chiefly in May or June and, according to the observation of most farmers who have had experience with it, the trouble occurs when hungry stock are allowed to gorge themselves on the green, juicy forage. It is commonly recommended that animals be given access to hay or straw while pasturing on sweet clover in order that they may mix such dry material with the green clover. The same procedure is worth observing for preventing bloat from any other green pasturage.

The common white sweet clover, as well as the less widely used and smaller yellow species (*Melilotus officiualis*), is a biennial plant. The so-called Hubam clover is an annual variety of the white sweet clover. In South Dakota, northern Iowa and Minnesota the second year crop is the one most often used for hay. Farther south the fall crop of the first year is finer stemmed and makes the better hay. This hay is proving equal to alfalfa in feeding value. In fact it is replacing alfalfa as a hay crop here and there on account of the low cost of seed and the ease of obtaining a stand. Through the corn belt abundant experience has been had in the use of sweet clover in 3, 4 and 5 year rotations. Your neighbor or the County Agent or the agronomist of your experiment station can best counsel you as to which plan to adopt for your particular farm.

An imported yellow flowered species of sweet clover (*Melilotus indica*) occurs as a weed, sometimes a very troublesome one, in the Western and Pacific States. It seems to be of little or no economic value. Thus far the sweet clovers have remained relatively free of serious insect enemies and diseases.



HEAD OF TEASEL

TEASEL (*Dipsacus fullonum*)

Teasel is a prickly biennial plant growing about 5 feet high and bearing close cylindrical heads 1½ to 3 inches long. These heads are composed of rigid bracts having elastic hooked points. They were formerly used by manufacturers to raise the nap on woolen goods and give the cloth a rough appearance. The culture of teasel in the U.S. is confined to a very few localities. The plant requires a moist climate for its best growth and a heavy clay or loam soil. The seed is drilled in rows 3 feet apart in April or May at the rate of a peck or more to the acre. The seed is lightly covered and the plants thinned to stand 6 to 12 inches apart in the rows. Corn is planted in the rows 5 or 6 feet apart for the purpose of holding the snow on the plants in winter, otherwise they may winter kill. The heads are not secured until the middle or last of July of the second year. They are cut off with 3 or 4 inches of the stem and placed on scaffolds arranged with plenty of air circulation above and below to cure.

The plant has been practically displaced by mechanical methods.

TOBACCO (*Solanum tabacum*)

Tobacco is the familiar broad leaved plant of the nightshade family, native to America and well known to the Indians of the days of Columbus. There are many species, some of them woody, but only one is used commercially for cigars, cigarettes, pipe and chewing tobacco, as well as for snuff and insecticide purposes. Tobacco may be raised almost anywhere from Canada to the tropics. But the quality and commercial value of the crop depends to a greater degree than any other farm crop upon special soil and climatic conditions. Thus it has come about that the industry is "highly specialized and the trade regularly looks to certain well-defined areas for its supply of the various kinds of leaf required. Each important district produces a tobacco of certain characteristics which make it desirable for special purposes. Efforts to introduce the commercial grow-

TOBACCO IN SOUTH CAROLINA

ing of tobacco outside of the established producing centers are likely to result in failure."

As outlined by Dr. W. W. Garner, tobacco specialist of the Department of Agriculture, there are several types of tobacco each one of which is associated with definite localities. Cigar tobaccos are grown mainly in the Connecticut Valley, the Miami Valley of Ohio, southern Wisconsin, Gadsden County, Florida and Decatur County, Georgia. The flue-cured tobaccos used for cigarettes and for smoking and chewing are produced in southern Virginia, the eastern portion of the Carolinas, southeastern Georgia and northern Florida. Fire-cured tobaccos are raised in western Kentucky and Tennessee and central Virginia. Smoke from open fires used in curing gives this type their special flavor. Their use is in snuff and plug wrappers. The Maryland type of tobacco grown in the southern part of the State is used in cigarette blends. Filler and binder tobaccos have come into prominence also in Lancaster County, Pennsylvania. The total tobacco production in the U.S. is 1¼ billion pounds on 1⅓ million acres, 750 million pounds coming from North Carolina and Kentucky.

The open-air wrapper and binder types of the Connecticut Valley and Wisconsin, as well as the shade grown types of Florida and Georgia, are raised on well drained sandy loam soils with a similar subsoil. About 200 square feet of seedbed in a cold frame is large enough to produce the seedlings for planting an acre. The soil in the seedbed is heavily fertilized and in fine tilth. The beds are sown between March 15 and April 15, and in the Connecticut Valley the plants may be set in the field May 15 to June 1. That requires 6 to 8 weeks in the seedbed if the cold frames are covered with glass, and 8 to 10 weeks if covered with cloth. An experiment with a plastic substitute for glass was disappointing since the plastic soon split and fell out of the frames. "When the plants have developed 4 to 6 leaves in height they are ready for transplanting. During the week prior to transplanting the plants should be hardened by removing the cover from the beds during the greater part of the day, increasing the period each day until finally, if the weather is favorable, the covers should be left off entirely."

Tobacco fields must be heavily fertilized. Formerly 10 to 20 tons of barnyard manure per acre was plowed under in the fall for next spring planting. Commercial fertilizers are applied in the spring, often 2000 to 2500 pounds of a high grade mixture to which 2 to 4 per cent of magnesia is added. The nitrogen in this mixture may come from castor pomace, cottonseed meal, urea and nitrate of potash. The tobacco stems contain about 5 per cent of potash and may be returned to the soil as a part or the whole requirement of potash.

In the flue-cured, or bright tobacco district, of Virginia, according to recent studies by the Experiment Station of that State, the most important qualities of soils for that type are good drainage, loose texture and ease of cultivation, such as are furnished by the sandy loams with yellow or red subsoils. The Virginia Station recommends a 3-year rotation of tobacco, small grain and red top, as providing non-leguminous humus and reducing erosion. If good tobacco land on a farm is so limited that no rotation can be followed and tobacco must be planted year after year on the same farm, "good results have been obtained by seeding rye on the field after the tobacco has been harvested, and plowing the rye under in the spring 4 to 6 weeks before the next tobacco crop is planted. The rye reduces the erosion and leaching during the winter and provides the needed organic matter in a form which will not supply too much nitrogen for good tobacco."

Cultural Practices. Up to the beginning of the present century, the greater part of the American tobacco crop was consumed as cigars, chewing tobacco, pipe tobacco, and snuff. Since that time there has been a rapid shift from these uses toward a greater consumption of cigarettes. In 1900 the per capita consumption of cigarettes in the U.S. was 35 a year; in 1910, 94; in 1920, 419; in 1930, 972; in 1938, 1257. This shift in consumption has created a demand for a milder and brighter colored tobacco, which in turn has necessitated certain changes in cultural practices. Formerly, rich oily leaves which could be used for plug wrappers were in demand. In order to produce such tobacco, it was necessary to space the plants 3 to 3½ feet apart, top them rather low, and use varieties which would produce tough pliant leaves. At present the demand is for cigarette tobacco which has thin, papery leaves. This is best produced by growing varieties which may be topped so as to leave 14 to 20 leaves to the plant. The plants are spaced 20 to 24 inches apart in the row. Such varieties are harvested by

pulling and curing the leaves as they ripen, rather than by harvesting the whole plant by cutting.

In the Virginia experiment superphosphate was found to be about the best source of phosphorus. Muriate of potash gave better yields than other forms of potash probably because of its content of chlorine which seems to be an important element in fertilizers for tobacco. The highest yields followed the use of a mixture of muriate and sulphate of potash-magnesia in equal parts. Matthews and Hutcheson found no advantage in applying part of the fertilizer in the furrows before transplanting, and the rest as a side dressing after the plants had begun growing. Their tests showed definitely that for high quality of flue-cured tobacco rotations should not contain legumes. For fire-cured tobacco, however, clover sod plowed under the previous fall gives good results.

With all types of tobacco, cultivation should begin as soon as the transplanted seedlings are established. The first cultivation may be deep but later ones should be shallow for fear of injuring the young rootlets. Cultivation should continue until the leaf-spread is so great as to expose them to injury from the cultivator.

As recommended by Dr. Garner: "When 10 to 15 leaves have appeared on the plant the top should be broken out, so as to force all the growth into the leaves left on the plant and cause them to grow larger, thicker, and darker. A favorite practice is to pick off and discard 3 or 4 of the bottom leaves, and then top the plants so as to leave 8 to 12 leaves on each plant. High topping tends to delay maturity and to produce a thinner leaf. The aim in topping is to leave only as many leaves on the plant as it can bring to the fullest development and as far as possible to insure that all plants will mature at about the same time. The suckers which develop in the axils of the leaves must be removed as often as they appear.

BREEDING PLANTS OF TOBACCO

"The plants generally are ready for harvest in about 30 to 40 days after topping. At this stage the leaves will have taken on a lighter color and become thick and heavy, and small yellow flecks will have appeared, especially near the edges of the leaf. It is not desirable to harvest the tobacco for 2 or 3 days after a heavy rain, as the gum which accumulates on the leaf in dry weather and improves its quality is washed off by the rain. In harvesting, the stalks should first be split with a knife from the top down to within a few inches of the bottom, in such a way as not to cut or injure the leaves. The stalk is then cut off near the ground and laid on the ground to wilt sufficiently to permit handling without breaking the leaves. The plants should then be placed astride sticks and hauled to the curing barn. In Virginia the plants are usually placed on the sticks before being laid on the ground to wilt. The sticks are 4 feet 4 inches long, and 5 to 8 plants, depending on their size, should be placed on each stick. The sticks carrying the plants should be arranged on the tier poles of the curing barn at intervals of 6 to 8 inches."

Tobacco is subject to many diseases. Many of them originate in the seedbed. The soil in the seedbed should therefore, be thoroughly sterilized by steaming. The seedbeds should be located as far away as possible from curing barns, tobacco fields or patches of weeds. Even the frames and covers of the seedbeds must be disinfected by formaldehyde corrosive sublimate or live steam. No old tobacco material should ever come near the seedbed.

But diseases will appear in the field even after careful attention to the seedbed. In the case of root rot, the land may be rested by several years of rotation, avoiding timothy, rye and legumes which seem to exert a bad effect on the tobacco roots. If tobacco wilt should appear, the crops just mentioned, as well as wheat and cowpeas, may be used since they are immune to the wilt. One remedy for the various leaf spots has been found in soaking the seed 15 minutes in a solution of 1 part corrosive sublimate in 1000 parts water. This is a deadly poison and the period of soaking must be precisely 15 minutes. Blue mold is a destructive disease which occurs from Pennsylvania to Florida, attacking and destroying the leaves. The trouble may be kept within bounds by repeated spraying of the young plants in the seedbed with a mixture of ½ pound red copper oxide and ½ gallon of cottonseed oil in enough water to bring the volume to 50 gallons, to which a quart of an emulsifier has been added.

Flea Beetle (*Epitrix parvula*) is of a reddish brown color, of minute size, and feeds upon potato, tomato, tobacco, jimson weed, etc. The beetle appears in July and feeds upon the leaves. This beetle is thought to be largely responsible for spreading the 2 tobacco diseases known as "frog eye" and "white speck." The destruction of all weeds belonging to the nightshade family in the neighborhood of tobacco fields, with the exception of a few clumps of such weeds which may be left as trap crops for the beetles, is recommended. These plants may then be thoroughly sprayed with arsenical poisons.

Bud Worm (*Heliothis rhexia*) is most injurious in the Southern States. The adult is a greenish moth with stripes across the front wings. The caterpillar attacks the bud of the tobacco plant and when occurring in large numbers causes considerable damage. This insect feeds upon the ground cherry and other related weeds. The bud worm attacks tobacco late in the season, boring into the seed pods and flower stalks. The eggs are deposited in the bud and the larvae feed on the undeveloped leaves, as well as the seed pods. Spraying with arsenical poisons may be used against these insects, but it is especially recommended that fine corn meal be poisoned with Paris green and shaken on tobacco plants.

Cigarette Beetle (*Lasioderma serricorne*) is very injurious to cultivated tobacco, feeding in all kinds of dry tobacco and snuff. It attacks also various other dried products and drugs. Leaf tobacco is punctured by these insects and rendered worthless for wrapping purposes. The beetle is found in most tobacco factories. This insect may be eradicated from tobacco establishments by careful removal of all dust and refuse and by fumigation with bisulphid of carbon. Infested buildings may be freed from the insect by steaming the walls after cleaning, or the walls may be cleaned and whitewashed for the same purpose.

VELVET BEAN (*Stizolobium* spp.)

Velvet bean is a trailing legume, growing to a length of 10 to 25 feet with thick surface roots well provided with nodules and often 20 to 30 feet long. A native of the Orient, it was brought to Florida about 1890. Until 1906 this was the only species of the bean in U.S. The beans of

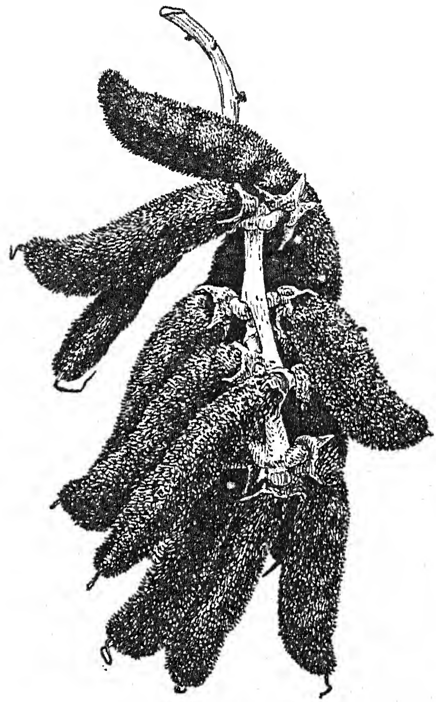
the species are borne in short cylindrical pods containing three to six large, spherical, brown and white mottled beans. The pods are covered with a black, velvety down which gives the name to the plant. In later years 20 or more other species have been introduced. For many years the velvet bean was grown in Florida as an ornamental for covering arbors and unsightly objects. Later it was found to possess great value as a green manuring and forage plant. In the earlier tests in Florida, Alabama and Louisiana it was found that in the lower half of the Gulf States it was equal or superior to the cowpea. Farther north it cannot take the place of the cowpea. The Florida velvet bean requires a frost-free period of 8 or 9 months.

The time of seeding, as suggested by W. J. Morse, can be determined by the frost lines on a meteorological map. Florida velvet beans are usually planted with corn in the case of late varieties, and somewhat later in the corn rows for early varieties. All except the Bush variety are mostly planted with corn, sorghum, pearl millet or other strong plants as a support to the climbing beans. Some farmers plant alternate rows of peanuts and corn with velvet beans seeded in the corn rows, the mixture to be harvested by hogs.

The Florida Station analyzed the crop at various stages of growth. The results showed that the best season for cutting the vines for hay is from the time the plants are in full bloom till the pods are well formed, but before the beans begin to swell. The crop is harvested with difficulty owing to the badly tangled vines. A mowing machine with the blades in front between the wheels was used for the purpose quite successfully. In recent years little attempt is made to grow these beans for hay because of the difficulty of harvesting, and because the hay, while ranging from 2 to 3 tons per acre, is coarse and not relished by horses or mules.

Velvet beans ground with corn to produce a mixed meal make an excellent addition to the ration of dairy cows or horses. Early varieties of velvet beans grown twining about corn stalks make a satisfactory and palatable silage for dairy cows. But it is as pasture that the velvet bean finds its most important use, especially for hogs and cattle in fall and winter. One-third to one-half acre per month per cow or steer for a 3-month period is the usual allowance. Hogs are turned in to follow the cattle since they find and eat the beans which the cattle may have wasted.

If grown alone velvet beans may be planted in rows 4 feet apart, dropping 2 or 3 beans in hills 2 feet apart in the row. Cultivation is helpful till the crop is thoroughly established, after which it is such a rank, close grower that it is able to keep down all weeds.



VELVET BEAN PODS

The Florida Station has found winter feed for a farm herd of cattle may be cheaply provided by turning the cattle in after the largest ears of corn have been picked. By this plan a cow per acre is about right for a 3 or 4 month period.

The high value of velvet beans as a green manure was shown in a series of experiments at the Alabama Station. Sorghum grown on a plot of ground where velvet beans had been plowed under, yielded 7000 pounds per acre as contrasted with 3800 pounds on a similar plot which had lain fallow the preceding season. Oats after velvet beans yielded 33 bushels per acre and only 8 bushels after millet, crab grass and weeds. On newly cleared or cutover lands 2 or 3 years of velvet beans not only furnishes much valuable grazing but helps in ex-

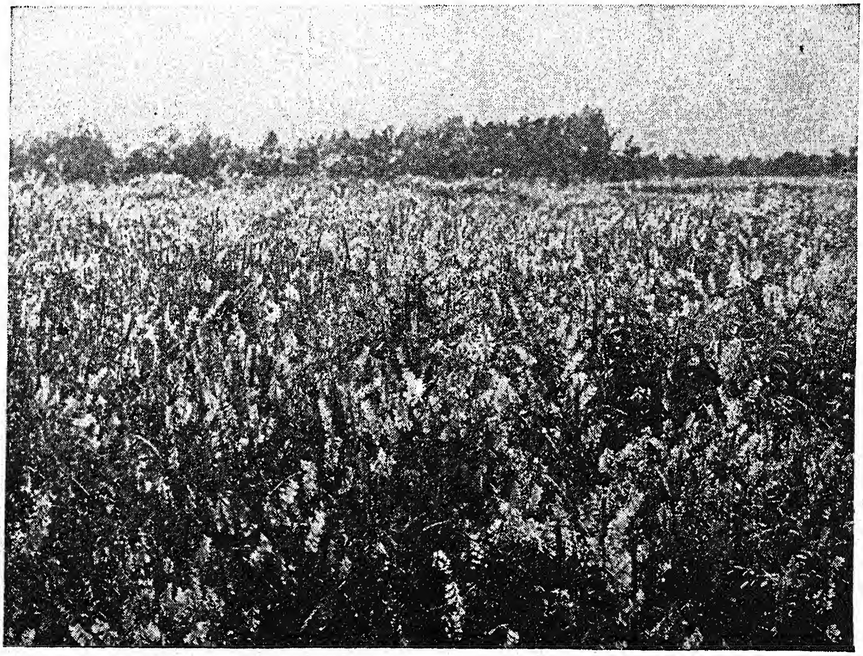
terminating weeds and in preparing the soil for less hardy plants. The amount of nitrogen provided by an acre of vines and roots varied from 131 pounds in Florida to 201 pounds in Alabama. The roots and stubble alone added 12 pounds of nitrogen to each acre of ground. Velvet beans are efficient weed eradicators. In Florida a freshly plowed field of densely matted Bermuda grass was planted to velvet beans. For the next 2 years no trace of Bermuda grass appeared. Farmers who have had experience with Bermuda grass will readily understand the significance of such an accomplishment.

Velvet beans are reported by the Department of Agriculture to be remarkably free from serious insect pests and diseases. Wilt and nematodes which worry cowpeas cause little concern with velvet beans. The velvet bean caterpillar sometimes causes serious damage, but, according to the Florida Station, may be controlled by dusting the vines with arsenate of lead or zinc at the rate of 3 pounds of arsenate of lead mixed with 12 pounds of air-slaked lime per acre.

VETCH (*Vicia* spp.)

About a dozen species of vetch have come to occupy a place in the list of farm crops of the U.S. Most of them are annuals and viny or of recumbent habit, the only exception being the horse bean (*Vicia faba*) which grows erect. The common species of vetch attain a length of 2 to 6 feet. The leaves are pinnate with many small leaflets, and end in a tendril by means of which the plant may climb. Mostly the flowers are purple and borne in long and rather showy racemes.

The vetches prefer a cool climate. In the north they start growth in early spring and mature in early fall, while in regions with milder winters their growth season is from fall to spring. The hairy vetch is about the only one which does well from fall planting in the north. A handsome native species, with deeper purple blooms, is a perennial and is often locally abundant. The Michigan Station finds the hairy vetch especially valuable on poor sandy soils. On such soils a mixture of rye and vetch makes a good growth. The lime requirement of vetch is less than that of most legumes. Vetches fix nitrogen only in warm weather. Hence they add little to the soil unless the crop is left until late in the spring. Where the rye-vetch mixture is used as an orchard cover crop it is best to disc it into the soil by May. Otherwise the mixture



VETCH AND WHEAT MIXTURE

may deplete the supply of moisture needful for the fruit crop.

Both leaves and stems of the hairy vetch are covered with a coat of fine hairs. The seeds are small and black and, since the pods burst open as soon as ripe, they will thus reseed the field. Seeding may occur from August to September or in April and May. For forage it should be sown with rye, oats or wheat for support. Fall sown crops produce some forage before winter comes, start early in the spring when the vetch may be pastured, cut for hay or turned under for green manure. Earlier seeding is sometimes to be recommended if the crop is for soil improvement than if grown for hay. The quantity of seed to be used per acre varies, according to locality and variety of vetch, from 20 to 70 pounds per acre. In general lighter seeding prevails in the south than in the north and the hairy and common vetches require less seed per acre than the Hungarian and Woollypod. The seed may be drilled or broadcast. Broadcasting is the older plan but drilling has the advantage of economy in the use of seed.

Interest in soil improvement and in the control of soil erosion has become so keen that Alabama recently planted nearly 4½ million pounds of hairy vetch seed in a single year, about ⅕th of it being home grown. Several other varieties produce as great a weight of vegetation as the hairy vetch which is most resistant to drouth but a rather slow grower in winter. In Alabama the Monantha vetch outstripped the others for purposes of green manure and proved to be about 2 weeks earlier in maturing than hairy vetch. The support provided by the small grain used in the mixed planting increases the yield of vetch seed, probably because the grain stems hold the vetch up in a more favorable position for seed development. The best method for harvesting vetch in Alabama, whether grown alone or supported by cotton stalks or small grain, was found in the use of a combine in which the proper adjustment and speed of the cylinder was planned to minimize cracking of the seed.

On inoculated soil at the Alabama Station vetch yielded at the rate of 2545 pounds of cured hay per acre, while on uninoculated soil the yield was but 232 pounds per acre. At that station the nitrogen contained in an acre of hairy vetch harvested when the plant was in full bloom was equivalent to the nitrogen contained in 2571 pounds of cottonseed meal. For that State the station considers it an especially valuable forage crop, since it covers the ground and continues to grow nearly all winter, furnishing pasture from February to May. If not pastured too late it furnishes a good crop of hay. The hay is cured like clover or alfalfa. According to analyses of the crop made at different stages of growth at the Alabama station, it should be cut for hay 3 or 4 days before the period of full bloom. The yield obtained at the station was 5789 pounds of cured hay. This contained 159 pounds of nitrogen and the roots 20 pounds more.

Hairy vetch seeded at the Colorado Station June 10, in rows 39 inches apart, at the rate of 30 pounds per acre, yielded 3⅛ tons of hay per acre. In this case the ground was cultivated 3 times and irrigated once. The plant remained green until December after 2 snows had fallen and the ground had frozen. The crop was readily eaten by cattle and horses and is recommended for pasturage in that State. Hairy vetch is becoming popular in the north as an orchard cover crop and is well suited for this purpose. At the New York Cornell Station the crop remained green all winter. The only objection to it is the high cost of seed. It germinates very poorly when over 2 years old. All stock relish the green forage and cured hay. Like the clovers, cowpeas and alfalfa it is a rich fodder especially suited for growing and breeding animals and for milk production.

The common vetch (*Vicia sativa*) is less hardy than hairy vetch, often winter kills even in the northern part of the Cotton Belt, but is fairly useful for hay, pasturage and green manuring in the Pacific northwest. The Willamette strain has recently become popular with farmers in Alabama interested in producing their own seed.

Winter vetch (*Lathyrus hirsutus*) is similar in habit of growth to spring vetch, being a trailing vine-like plant. It is very successfully grown all through the South, being especially valuable for late fall and early spring pasturage. It has not been found hardy north of Maryland. Like the other vetches, it is sown with rye, wheat or oats at the rate of about 2 bushels of vetch to 1 bushel grain. Seeded in August it furnishes forage in November and December and can be cut for hay in the spring. It should be cut for hay when in full bloom and requires about the same care in curing that cowpeas do.

Kidney Vetch (*Anthyllis vulneraria*). This crop has been tested at a number of experiment stations but not found promising. It is extensively grown in Europe on thin calcareous soils too poor to grow other crops. It is a perennial legume usually seeded in the fall with grain at the rate of 18 to 22 pounds per acre. It makes some growth after the grain is removed the following summer, but does not give a full crop until the second year. The yield of hay is small and the plant is of little value except on poor, sandy soils too infertile for clover.

The common forage bean of Europe is the English, broad, or horse bean (*Vicia faba*). It is an erect growing plant with large flat usually rounded seeds. It has been planted as a forage crop at several stations but has not proved successful in our dry hot summers. In Canada it is ensiled with corn, making a silage known as the "Robertson Mixture." It is much less sensitive to frost than other sorts of vicias and therefore can be planted much earlier in spring. Plant in stiff clays or clay loams in drills 18 to 24 inches apart, using 6 to 8 pecks of seed per acre, cultivate shallow between the rows until the vines touch. On good soil the yield is 25 to 30 bushels per acre. The beans should be ground before feeding to stock.

Vetches grown for seed are more subject to injury from insects and disease in Alabama than those turned under in the spring as soil renovators. Applications of insecticides to vetch fields are rather impracticable. Leaf spot, black stem, and root rot may also attack vetches but no good measures for controlling these troubles are known other than suitable crop rotations.

WHEAT

Wheat stands at the head of the list of cereals both in value and volume of production. By 1940 the world crop had passed 6 billion bushels and is still increasing. It should not be forgotten that rice is the principal cereal of the Orient where it is eaten daily by at least one-third and perhaps one half of the population of the globe. But wheat is par excellence the cereal of the western world and is gaining in acceptance as a rival of rice among the oriental peoples. The vital importance of wheat in the human diet has caused it to be the source of more international squabbles and legislation than any other cereal. Never a time in modern history has wheat been permitted to ripen and move on through the channels of trade to the breakfast table without being spied upon and regulated. In England alone, prior to 1815, more than 15,000 acts, repeals, amendments and re-enactments had been aimed at regulating the price of wheat and bread. And the end is not yet.

The wild plant from which this food cereal originated, and the place and time where it first attained the stature of wheat, are still the subject of controversy. The evidence points to central or western Asia. Since ancient times it has been cultivated in Palestine and Egypt. Grains of wheat were buried with the mummies of early Egyptian dynasties.

Since 1900 the annual wheat crop of the U.S. has varied from 42 to 70 million acres and from 496 to 946 million bushels. About ¾ of the wheat produced in this country is grown in the winter wheat belt from Kansas and Nebraska to Virginia and New Jersey, and in the spring wheat belt of the Dakotas and Minnesota, but Whitman County, Washington has often been the banner wheat county with a crop of 10 million bushels. Spring wheat is raised chiefly in Minnesota, the Dakotas and in the Palouse and Big Bend districts of eastern Washington, and the center of the winter wheat area is in Kansas, Nebraska and Oklahoma, while a considerable acreage of this crop is grown from southern Illinois to Maryland and Delaware. Along the southern margin of the wheat belt early maturing varieties are essential because of the prevalence of rust toward the end of the season. Rust may reduce the yield of late maturing varieties by 10 or 12 bushels per acre during the last week before harvest.

Wheat requires a very fertile soil for its best growth. Rich clays and heavy loams, when well drained, give the heaviest yields, though good results on lighter soils may be obtained when they are in proper condition and the season is favorable. Calcareous soils are also considered good wheat lands.

Preparation of Seed Bed. Early plowing for fall wheat is especially desirable. At the Oklahoma Station portions of a field that had been into oats were plowed July 19, August 15 and September 11. The plats plowed July 19 and August 15 were harrowed at intervals to keep down weeds and maintain a loose surface soil. The yield from the plat plowed first was at the rate of 31.3 bushels per acre; plowed second 23.5 bushels and plowed last 15.3 bushels. That is, the crop was about doubled by early prep-

aration. The moisture content of the different plats in this experiment was determined 3 days before seeding. It averaged 16.8 per cent for the plat plowed July 19; 13.9 per cent for the plat plowed August 15; and but 7.7 per cent—4 per cent less than the amount required to germinate seed wheat readily—in the plat plowed last. The weeds left to grow on the unplowed plats dissipated the soil moisture and left the ground hard and dry. Moreover, the early prepared plats plowed easily and the ground turned up mellow, while the late prepared plats were hard to plow and the ground turned up hard and lumpy, and was very difficult to bring into condition for seeding. Like experiments at the Minnesota and Michigan Stations, on oat lands, gave very similar results. The heaviest yields were obtained from the early plowed fields, and the cost of preparation was less. "Briefly stated, early plowing followed at intervals by harrowing, prevents the growth of weeds, conserves the moisture of the soil, keeps the soil in good tilth, and results in the formation of a seed bed best suited for the prompt germination and growth of the seed. The cost of preparing the ground is lessened, the yield of grain is increased, and the practice is financially profitable."

Experiments in deep and shallow plowing for wheat show that depth of plowing is not of so much importance as a firm seed bed, the upper 3 or 4 inches of which is mellow and in good tilth. As with other cereals, subsoiling is not financially profitable with wheat. Summer fallowing is in favor with many wheat growers. Where the fallow is frequently cultivated, it cleans the land of weeds and makes a good preparation for wheat; but it has been demonstrated over and again that summer fallowing as a farm practice is generally poor business policy. (*See Rotation of Crops.*)

In many farm rotations wheat follows corn. If fall wheat is grown and the corn stover cut for fodder, a couple of cultivations with a good spring tooth harrow will put the ground in good condition for wheat. In sections where spring wheat is grown the seed bed should be fall plowed. In the spring the ground should be run over about twice with a cultivator or harrow before the seed is sown.

Many farmers roll the seedbed. On heavy lands this is of no advantage, but on lighter soils it firms down the seedbed, thus insuring a more even germination of the seed and a more certain contact with soil water, and would seem to be desirable, especially in dry seasons. In Utah rolling and harrowing after seeding increased the yield a little over 3 bushels per acre. On the value of rolling wheat lands in the west the Department of Agriculture states as follows: "A roller should never be used on the Western plains, except in the case of late plowing, and even then it should be used only before drilling. This is owing to the fact that roughness of surface is valuable for holding moisture, and checking the injurious action of dry winds. The seedbed should be made very fine and mellow before drilling, and whenever possible the drill rows should run east and west. Strict attention to such general principles as the foregoing will result in an increase in certain seasons of as much as 5 or 10 bushels per acre."

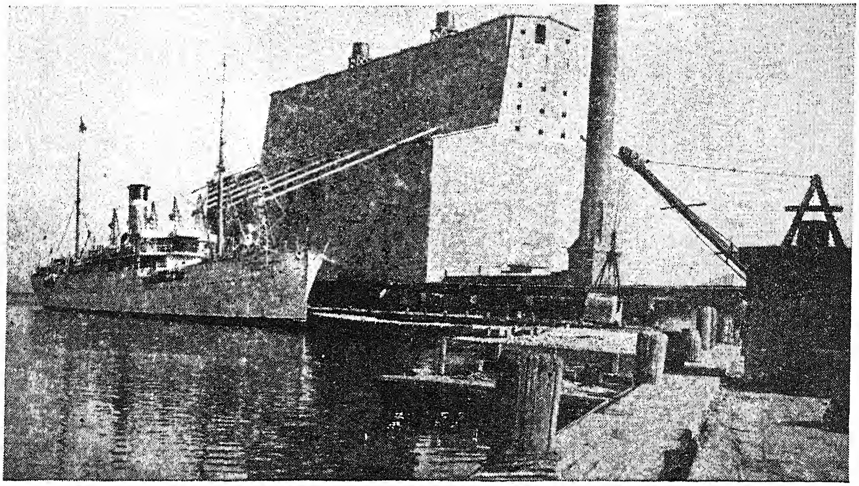
Seeding and After-Culture. The time for seeding fall wheat in the North varies between the 10th and last of September. In the more Southern States wheat is put in from the middle of October to the middle of November. The aim in any locality is to give the plants a good start before freezing weather sets in. Experiments in Kansas and Oklahoma indicate September 20 as about the right time for seeding in those sections. Spring wheat should be sown as early in the season as the soil and weather will permit. For best results it is considered a safe rule, with either fall or spring wheat, to sow at a period which is considered early in the locality where the seeding is done. An exception to this occurs where late fall seeding is practiced to escape the ravages of the Hessian fly.

Whenever possible wheat should be drilled in rather than broadcasted. Wheat seeded with a press drill at the Iowa Station gave considerably increased yields over seeding with a common drill. Seeding wheat in drill rows far enough apart to allow of cultivation has not given as large yields in this country as by close drilling in the ordinary way. Many experiments at the different stations show that there is very little difference in the results whether wheat is seeded 1 or 3 inches deep. On the drier soils, however, the greater depth will give the better results.

The amount of seed to sow will vary with a number of factors. If the seeding is done early and weather conditions are favorable, the plants will stool better and less seed will be required. Again a bushel of small-grained wheat may contain 2 or 3 times as many kernels as the same amount

of large-grained wheat, and hence furnish 2 or 3 times as many plants per acre. All things considered, and one year with another, about 6 pecks per acre will give the best results. If the seeding is done early, and the land is fertile, 1 or 2 pecks less may be used; but if the seeding is late, and hence less opportunity given for stooling, or if the seed is broadcasted, 1 or 2 pecks more may be profitably sown.

Fall wheat is sometimes harrowed in the spring. Experiments show that this practice usually results in decreased yields. Pasturing off wheat is not generally profitable. At the Indiana Station mowing the wheat when the plants were about 6 inches high retarded the growth and reduced the yield of both grain and straw.



WHEAT ELEVATOR IN GALVESTON

The efforts of plant breeders have brought into existence a great number of wheat varieties adapted for special uses and to particular regions. These kinds and varieties have been grouped into several fairly distinct wheat regions. The soft wheat district includes the Middle Atlantic and New England States as well as Virginia, West Virginia, and Kentucky, with Fultz, Trumbull, Purple straw and Forward among the popular varieties. The semi-hard wheat district comprises Ohio, Indiana, Illinois and Michigan in which Garnet, Triumph, Reward, and Komar varieties are held in high esteem. The Southern district covers Tennessee, Kentucky, N. Carolina, S. Carolina, Georgia, Alabama, Missouri and Arkansas with Fultz, Rice and Purple straw among the preferred strains. The hard spring wheat district extends from Minnesota to Iowa and west to Montana with several strains of Fife and Blue Stem as prominent varieties. The hard winter wheat district mentioned above shows preference to Turkey, Kanred, Thatcher and other varieties. The durum district, extending through the Great Plains from Texas to Manitoba, is distinguished by its hard macaroni wheats. The white wheat district includes the Pacific coast and Idaho, and boasts of 44 varieties of winter and spring wheats, characterized by a relatively white kernel. The white wheats are also grown in N. Dakota, Montana, Colorado, Utah, New York and Michigan.

Fertilizers. On the rich soils of the Mississippi valley and Western States, the use of commercial fertilizers for wheat has not been profitable. In many Eastern and Southern States, where the soil has become depleted, fertilizers are desirable. In Indiana and Illinois the use of barnyard manure has resulted in better yields of wheat than where commercial fertilizers have been used. Coarse, unfermented barnyard manure should not be applied to wheat; but a dressing of finely composted manure makes one of the best fertilizers for this crop. Where wheat follows corn in the farm rotation the coarse manure should be applied to the corn crop. The manure is thus thoroughly rotted before the wheat is seeded and the weed seeds it contained have germinated and been destroyed. On the ordinarily fertile wheat lands nitrogen and

phosphoric acid are the fertilizer elements most concerned in the production of the wheat crop, potash being of less importance.

The following ideal fertilizer formula for wheat is recommended by the Georgia Station for the soils of that State: At seeding time 200 pounds of acid phosphate, 50 pounds of muriate of potash and 350 pounds cottonseed meal per acre. In the spring a top dressing of 75 pounds of nitrate of soda per acre should be applied broadcast about a week or 10 days before the first heads appear. At the New Jersey Experiment Station the use of 150 pounds of nitrate of soda per acre applied broadcast soon after growth started in the spring nearly doubled the yield. Nitrate of soda should be applied only when the leaves are dry, and preferably just before or just after a rain, so that it will be dissolved for the use of the plants at once.

Wheat does well when sown after catch crops like beans or cowpeas. Clover stubble or any of the legumes turned under make good preparatory crops for wheat, since all these crops leave the soil richer in nitrogen, besides adding humus to it. It has been found more profitable, by the Arkansas Station, to pick the peas and plow under the vines for wheat than to plow under the entire plant.

In those sections of the country where the use of commercial fertilizers is necessary in wheat growing, the experiment station of the State should be consulted as to the best combinations and forms to use. The stations make it their business to be informed on these points, and their advice may save the buyer money, and at the same time give correct notions as to the rational use of these expensive materials.

In all the States where irrigation is practiced wheat is one of the crops to which water is thus applied. In Oregon the amount of irrigation applied to wheat averages about the same on the various projects such as the Umatilla and Deschutes areas, the Malheur valley and the Boise region, namely about 27 inches. Some farmers use more but ordinarily no more is required. Some of the new projects are designed to supply 3 to 3½ feet of water per season. The number of applications per year varies from State to State according to seasonal climatic conditions. In Utah it has been found that night irrigation is better than the use of water in daytime. Two applications of water during the spring upon fall sown wheat seems about right. The hardness of the grain is affected by the amount of water used. Overirrigation, especially if done near the maturity of the crop, may produce a soft and inferior kernel. Experienced irrigators find that the depth of color of the wheat leaves may be taken as an accurate guide as to the right time to apply water. When the available moisture content of the soil is nearing exhaustion the leaves turn to a decidedly darker green than normal. If water is withheld beyond that point the leaves begin to curl and wilt. Beginners in irrigated farming often make the mistake of applying too much water. This produces one or both of two bad effects, smothering of the wheat roots, and bringing alkali to the surface. It is easy to overdo the job of irrigation and thousands of acres have been almost if not quite irrevocably spoiled by so doing. To play safely with this practice the farmer must carefully study the water requirements of his crop.

Harvesting. The harvesting of wheat should begin when the grain is fully in the dough stage. At this time it can be easily compressed between the thumb and finger, and still is not milky. The cutting should be complete by the time the grain is fully ripe. At the Indiana Station harvesting the grain when in the hard dough stage resulted in the largest yield. If harvesting is deferred until the grain is dead ripe, much grain will be lost by shattering. Where the crop is harvested as soon as the grain is mature, that is, in the hard dough or ripe stage, there is little loss in the feeding value of the straw; but if the harvesting is delayed until the grain is overripe the straw loses much in feeding value and the grain is not improved.

Many persons now living have witnessed the history of harvesting methods run through the stages from the grain cradle to reapers, self binders, headers and combines, during which horse drawn or motor machines have replaced hand work. Headers and combines, however, are not practicable in most eastern farms with small fields. There the wheat is cut with binders, stacked in sheaves where it is allowed to cure, after which it is threshed directly from the shock in the field, or hauled to the barn and later threshed from the mow. Grain combines in the vast commercial wheat areas of the Western States have made a thing of the past of the former army of migratory laborers who followed the wheat harvest

from Texas to Canada as the season advanced.

Selecting Seed Wheat. This is perhaps the most important operation in wheat growing. It is quite generally believed among farmers that seed wheat grown on the same farm, year after year, will deteriorate or run out. Years of careful experiments in Indiana, Pennsylvania, North Dakota, Minnesota and other Stations, show conclusively that this idea is wrong. As the result of a study on seed exchange the N. Dakota Station states as follows: "Varieties of wheat do not degenerate because of continuous growth upon the same soil. The theory that wheat culture demands a frequent change of soil is fallacious. . . . Smut and weeds are often introduced by change of seed. . . . Only perfectly formed, plump, hard grain should be seeded, but each farmer should grow his own seed, attempting to bring it to the highest grade of perfection and purity of variety by proper methods of selection and culture without seed exchange. This will insure pure varieties, freedom from smut, less weeds and heavier yielding, better milling qualities."

The Pennsylvania Station states in this connection that "where the soil, cultivation, manuring and seed selection are not the best it will pay a farmer to change his seed occasionally."

Relative to methods of selecting and improving seed wheat, the Department of Agriculture states as follows:

"Begin practicing the constant use of a wheat-breeding plat of one acre or more from which to select seed each year. Locate this plat at different parts of the farm every 2 or 3 years, preferably in alternation with clover or other leguminous crops, and give it the best of care. Just before harvest go through a field of good, hardy, standard variety that has given the best results in the locality, and mark plants that exhibit to the highest degree the special quality which it is desired to increase, such as freedom from rust, fertility of head, or otherwise, and which are at the same time at least as good as the average in other respects. At harvest time cut with a sickle enough of these marked plants for sowing the plat, and after threshing them, select the largest and most vigorous seed for this purpose, by means of a screen or even by hand picking. Sow the plat early, drilling it at the average rate of about 1¼ bushels per acre. Next season use none of the field crop for seed, but select in the same manner enough of the best plants from this breeding plat for reseeding the plat and use all the remainder for sowing the general crop. In the following season, and each succeeding season, practice exactly the same method. In this way seed is never taken from the general crop, which cannot be given the same care as the small plat, and there is a constant selection of seed which is more and more rigid every year. Moreover, there is no extra labor involved except the small amount required for seed selection each year. Of course the breeding plat should be kept constantly free from rye or other foreign heads and weeds."

Durum wheats are spring varieties with extremely hard kernels and thick, short compact heads. The kernels of most of them are amber in color. These wheats are used chiefly for the manufacture of semolina from which spaghetti, macaroni and other paste foods are made. About 5 million acres of durum wheat are raised almost exclusively in the northern Great Plains, particularly in the Dakotas and Montana. The center of production during the past 20 years has moved northward and westward. In the Pacific and Intermountain States other varieties of wheat outyield the durums, while in subhumid or humid regions the kernels are soft, starchy and unsuited to the special purpose which durum varieties serve best.

According to the Department of Agriculture, little if any flour is made from durum wheat alone. Of the average domestic consumption of 32 million bushels, about half is milled into semolina, while the rest is blended with other kinds of wheat for flour or fed to stock. Durum wheat also has the virtue of being highly resistant to orange leaf rust. Long awns are another feature of these wheats.

Of the 10 commercial varieties of durum wheat raised in the U.S. Kubanka introduced from Russia is the leader in total acreage. Mindum has outyielded other varieties in Minnesota, although it is not particularly rust resistant. Arnautka is taller than Kubanka and more susceptible to stem rust. Peliss has large thick heads, was introduced from Algeria in 1900, but has not proved resistant to stem rust.

The Polish wheats are known in the U.S. chiefly through the White Polish, a variety with tall, smooth stems, rather sparse stooling and extremely large, loose heads of a bluish-green color. The kernels are very large, long, yellowish-white and very hard. Polish wheat requires adequate moisture at seeding time, but

is well adapted to arid climates where it thrives abundantly. The grain is similar in character to that of the durums.

Spelt (*T. spelt*). The grain generally called spelt, speltz, spiltz or spelz in this country is really emmer. True spelt is scarcely, if at all, grown in the country. The spikelets of true spelt are usually far apart in the head. They are arched on the inside and stand out from the rachis, forming a loose head. The grain is held tightly within the chaff and is not hulled out in threshing.

Emmer (*T. dicoccum*) is quite generally miscalled spelt in this country. Emmer, however, is a hardier plant than spelt. It has been successfully grown in a number of Northwestern States and promises good results as a drouth and rust resistant wheat. "It will produce a fair crop under almost any condition of soil and climate but thrives best in a dry prairie region with hot summers, where it gives excellent results." Emmer is used as a stock food but not for bread in this country. Analyses of the grain at several stations indicate that it has nearly the same feeding value as wheat. In sheep feeding experiments it has not proved quite equal to barley. For steers it gave slightly better results at the Canada Stations than a mixed ration of oats, wheat screenings and barley. The emmer was ground with the chaff on in the Canadian experiment. It weighed from 41 to 43½ pounds per bushel. Yields of 25 to 65 bushels per acre are reported by different experimenters and stations.

Both winter and spring forms of emmer are grown and some of the latter are very hardy. Spring varieties are most popular. In Canadian experiments the best yields have been obtained by seeding at the rate of 1¾ bushels per acre. Its culture is entirely similar to that given for wheat above.

Cut green and cured at the Iowa Station, emmer proved no better for forage than any other cereal. Its present value in this country, aside from its usefulness in crossing with easy shelling varieties, will depend on its ability to outyield the other cereals or develop on poorer soils or in a more severe or drouthy climate.

Wheat is seldom used for feeding stock, except when the price is unusually low or the grain becomes damaged. It contains a relatively high percentage of protein in proportion to its starch content, and therefore forms a more nearly balanced ration in itself than corn. On the whole, it has proved about 10 per cent less efficient for fattening purposes than corn, but is better suited for young and growing stock then corn. To horses it should be fed whole. Experiments in the North Dakota Station indicate that it is not desirable to feed it alone. Many of the grains pass through the alimentary tract unbroken, and it is difficult to keep the horses from getting "off feed." Wheat bran and shorts, on the other hand, proved about equal to oats for work horses and mules at the same station.

Experiments at the Ohio Station show that wheat meal, while very satisfactory for fattening steers, is not quite so effective for this purpose as corn meal. For dairy cows wheat meal and corn meal proved about equal in feeding value at the Maine Station; while at the Ontario Agricultural College a mixture of oats, peas and barley proved more effective for milk production than wheat bran.

At the Michigan Station it required about 8 per cent more wheat grain to produce a pound of gain with lambs than when corn was fed. Foreign experiments indicate that whole wheat is nearly as satisfactory a feeding stuff for sheep as oil meal or cottonseed meal.

With pigs the results of tests at 4 stations show that wheat meal is about equal to corn meal for fattening purposes. A mixture of the two gave slightly better results than corn meal alone at the Wisconsin Station. Experiments at the Indiana Experiment Station indicate that wheat for pigs should be crushed or broken before feeding. Soaking the whole wheat did not prove of much benefit. Sheaf wheat fed to pigs at the Oregon Station proved unsatisfactory for fattening purposes, and is not to be recommended. Wheat bran proved only about half as valuable as middlings at the Maine Station.

From these data some idea may be obtained as to when wheat can be profitably fed to stock. Ordinarily it will be cheaper to grow corn for this purpose. Shrunken and slightly damaged grain should always be kept as a stock food. It is practically as valuable for this purpose as the wheat which brings the highest market price. It should be fed in limited amounts, and preferably with other grains.

In mastication, wheat grain and flour form a pasty mass, which adheres to the gums of animals. This can largely be prevented by feeding it with some other material like bran or shorts.

Enemies. In this country wheat is attacked by 3 species of rust: stem rust,

confined mostly to the stem and leaf sheath, leaf rust and stripe rust. According to the Department of Agriculture stem rust requires common barberry as a second host on which to complete its life history. In the Southern and Pacific States it passes the winter on wheat and perennial grasses and does not need the barberry to continue its existence in those States. It cannot survive severe winters except in the spore stage. But the other two rusts may survive the winter in the leaves of the wheat. "The spread of stem rust through the wheat States from Texas to Canada depends on the gradual northward movement of spores." From barberries along the way, and the constant supply of spores from the South rust may make its way across the wheat belt in a few weeks. Losses from stem rust have run as high as 180 million bushels in Minnesota, the Dakotas and Montana. Observations made in airplanes at high altitudes show that the spores may be borne in the upper air currents for 1000 miles or more. Leaf rust also causes large yearly destruction, while stripe is confined to the far west and is not very serious.

Spraying or dusting for rust is of little value and is too costly. Destruction of barberries helps and millions of them have already been eradicated. Rust resistant varieties of spring wheat, such as Ceres, Hope, Kanred and others give much promise. Several strains of resistant winter wheat have also been developed.

Wheat is also subject to the attacks of 4 kinds of smut. Except on the Pacific coast and Great Basin, where smut spores remain in the soil indefinitely, the stinking smuts may be readily controlled by treatment of the seed wheat. Wetting the seed with a solution of copper sulphate or formaldehyde is very effective, or the seed may be treated with finely powdered copper carbonate. In the humid wheat areas the common loose smut may be controlled by subjecting the seed to a heat of 129 degrees F. in water for 10 minutes. Resistant varieties such as Kanred, Turkey and Fulcaster help to prevent damage from the fourth kind of smut known as flag smut, which is mostly confined to Kansas, Missouri and Illinois.

Scab is another serious disease most prevalent in the corn belt and affecting corn as well as wheat. It appears in the heads of wheat as an orange or pink coating. Losses from this disease may be reduced by plowing under the corn stubble, not allowing a wheat crop to follow corn, by treating seed with a standard fungicide and planting resistant varieties of wheat.

Hessian Fly (*Cecidomyia destructor*) is a small 2-winged fly, ⅛ of an inch long, of a dark color. It appears in May and June and again in September and October. The eggs are laid on the upper surfaces of the leaves and the maggots after hatching penetrate into the stalk. The change into the flaxseed stage is made while lying between the sheath and the stalk. The insect passes the winter in the flaxseed stage and emerges as a fly in the spring. Wheat stems are weakened by this insect, so that they break down. Late seeding, burning the stubble after harvest, the use of resistant varieties, and sowing a small area of wheat early for the purpose of plowing it under after it is 2 or 3 inches high and infested by Hessian flies, have been recommended as preventive methods. A long drouth in early fall, retards the second brood, and the seeding time should be regulated accordingly. The time of appearance of the broods is much influenced by altitude and latitude. After the usual date for the appearance of the fall brood of the Hessian fly has been determined for any given locality, the practice should be not to sow wheat earlier than this date.

Joint Worm (*Isosoma hordei*) deposits its eggs in the stems of growing wheat and other cereals. Wheat stems infested by this insect show swellings at and between the joints. These swellings are woody and upon being cut open, cavities are found in each of which there is a yellow larva of the joint worm. As this insect passes the summer, fall and winter in straw and stubble, much benefit may be derived from burning over the stubble fields. Grain may be cut high and the stubble again cut off close to the ground and raked up for composting or bedding. Where this method is not practicable, stubble should be burned.

Stem Maggot (*Meromyza Americana*) is yellowish-white with a black spot on the head and 3 black stripes on the abdomen. The adult resembles the housefly but is smaller. The maggots are found in wheat stems just above the joint. They are green in color and taper toward either end. Insecticides are of no avail against this species. It is recommended that stubble be plowed under or burned annually after harvesting, although these methods are not so effective against the stem maggot as against the Hessian fly and joint worm.

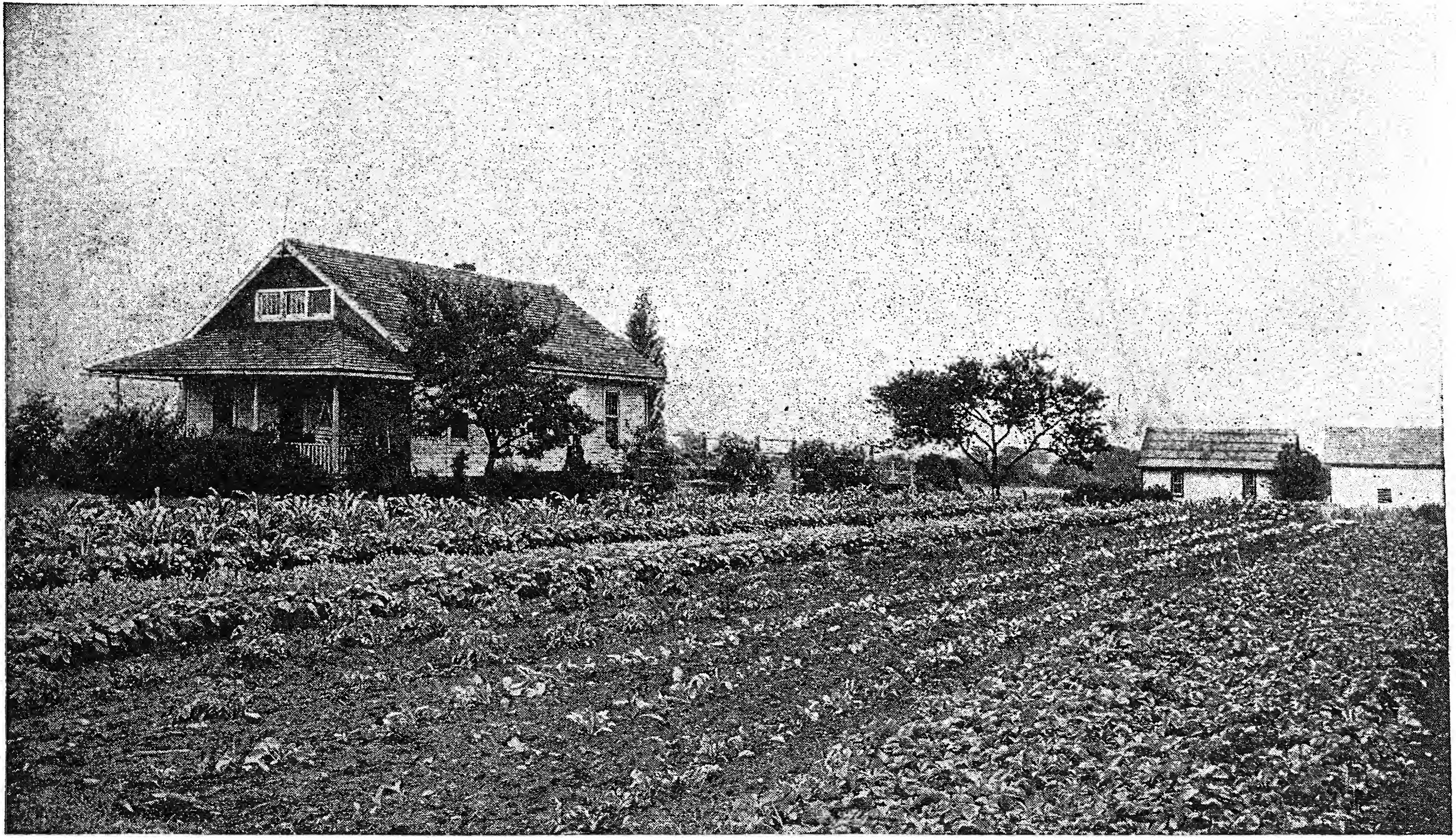
Chinch Bug (*Blissus leucopterus*) is

1/7 of an inch in length, with a black body and white wings, and a black spot on the wings. The young is at first yellow, later orange, then red. After a few molts the young insect has the appearance of the adult. There are 2 or 3 broods per year. The chinch bug is distributed throughout the whole eastern part of the United States, and as far west as Colorado and New Mexico, and in small areas in California. It feeds almost exclusively on grasses and cereals and is often a serious plague. The chinch bug passes the winter in the adult stage in stools of wild grasses and under fallen grass and other rubbish. Usually 3 migrations of the pest are observed annually. One in May, another in midsummer and the third in the fall. The adults appear with the first warm days of spring and the eggs are laid on the roots of wheat and other plants. Hot, dry seasons are most favorable for their development, and prolonged periods of damp weather are fatal to the insect, especially on account of the prevalence of fungus and bacterial diseases during such periods. In combating this insect rotation of crops is of limited value for the reason that the chinch bug attacks corn, millet, sorghum and other field crops, in addition to the cereals and grasses. The distribution of bacterial and fungus diseases especially of white fungus disease, is not a very efficient means of combating the chinch bug. Several experiment stations kept a supply of diseased chinch bugs for free distribution among the farmers, but the results from such distribution have not been very encouraging. Infested grass lands and stubble fields should be burned over and all rubbish under which the bugs might hide should be destroyed in the same way. They may be destroyed while migrating from one field to another by tar barriers or deep furrows and by being buried under the ground by means of plows or harrows. A narrow strip of grass may be sown around grain fields and turned under as soon as badly infested with the bugs. In corn fields they may be readily destroyed by spraying with kerosene emulsion.

Granary Insects A number of insects are especially injurious to stored grain. The most common and injurious ones are Angoumois grain moth, rice weevil, granary weevil, Mediterranean flour moth, meal snout moth, Indian meal moth, flour beetles, cadelle and sawtoothed grain beetle. As seen from their names, some of these insects are moths and some are beetles. They not only injure stored grain, but attack all sorts of dried food products. It is not considered necessary to describe the different species in this place. New grain should not be stored in old bins which are known to be infested until they have received a thorough disinfectant treatment. The best treatment for infested grain consists in fumigation with carbon bisulphid. This substance may be poured into shallow pans and set on the grain. It evaporates rapidly and the fumes soon penetrate the whole building. The carbon bisulphid should be used at the rate of 1 pound to 100 bushels of grain. Bins and granaries should be made as tight as possible before treatment and should be kept closed for from 24 to 48 hours. The cost of treatment is only 10 to 15 cents per 100 bushels of grain. Bisulphid of carbon is highly inflammable and care should be exercised accordingly. A lighted match in the vicinity of the fumes will cause an immediate explosion.

PART II

GARDEN CROPS



FARM HOME VEGETABLE GARDEN

GARDEN CROPS

THE GARDEN

The garden is or should be a permanent and integral feature of every farm in which the whole family takes an active part. Usually it lies in the rear portion of the farmstead grounds, which comprise a landscaped yard with ornamental shrubs and shade trees, flower beds, sometimes a few hives of bees, an herb garden for seasonings and medicinal plants, and the vegetable garden plot. The natural essentials of a good garden are that it should be sunny, fertile, level or only slightly sloping, well drained and rectangular. The garden is expected to produce a continuous succession of fruits and vegetables throughout the growing season. That performance demands sunshine, fertility and a deep mellow soil with a slope toward the south if any. The faster the garden crops grow the more crisp, juicy and highly flavored they are, and the sooner another crop may follow them.

Every spring a heavy application of barnyard manure, if available, should be spread over the soil before plowing, about 20 bushels per 1,000 square feet, or 5 bushels of hen manure. If manures are not to be had, some other organic material, such as compost, may be used, or a winter cover crop may be plowed under. For compost, grass clippings, leaves and all sorts of vegetable waste, may be gradually built up during the season in a heap at the side of the garden with alternate layers of soil between the masses of other material. Unless the soil is sweet, about 75 pounds of lime per 1,000 square feet should be applied, particularly for onions, cabbage, lettuce, peas and spinach. Peppers and tomatoes may have less need of lime. After plowing, a good grade of commercial fertilizer, containing nitrogen, phosphoric acid and potash, should be broadcast on the soil and harrowed or raked in, about 40 pounds per 1,000 square feet, on unmanured soil, or 25 pounds if manure has previously been applied.

How much and which kinds of vegetables to plant, are questions to be settled in family consultation in advance of outdoor operations. With the exception of old experienced gardeners, who may prefer to raise the garden plants from seed up to the planting stage in hot beds, it will perhaps be more satisfactory to buy plants of head lettuce, tomatoes, cabbage and pepper. For small gardens, winter squash, pumpkins and cucumbers take up too much space. Potatoes can be more economically grown on a large scale as a field crop. Tomatoes, bush string beans, carrots, beets, cabbage and spinach are often recommended for small gardens in New England. In western Washington it is suggested that head lettuce, onions and spinach be planted as early as the soil can be prepared in the spring. After severe spring freezing has passed, turnips radishes and kale may be planted, followed 2 weeks later by beets, carrots, parsnips and leaf lettuce, and finally beans, egg plant and sweet potatoes. In Georgia a continuous supply of leafy crops is urged, such as lettuce, spinach, turnip greens, collard, cabbage and chard, besides carrots, beets, onions, peas, okra, tomatoes and string beans.

In Washington it has been found that a well planned garden of ¼ to ⅓ acre in size may produce enough vegetables for a family of five, not only for fresh table use but also for canning, drying and storing. Inquiries in farm homes in that State showed that 65 to 75 per cent of all food needs for the average farm family can be produced on the farm. Those figures of course, include fruit, dairy products and meats as well as garden vegetables. The farm orchard, usually located near the vegetable garden, may include 1 summer, 1 fall and 1 winter apple tree; and 2 trees each of prune, pear, peach, apricot, sour cherry and sweet cherry, besides raspberries, strawberries, blackberries and currants. Selections for the home fruit yards in other States will vary according to the adaptability of the various kinds of fruits.

Gardens assume great importance in wartime on account of the scarcity of farm labor, and the consequent reduction in food output. Materials as well as labor become scarce, and it is often imperative to select for the garden those crops which normally require the least spraying or dusting for disease and insect pests, and to choose a time for planting which will

enable these crops to escape their enemies as far as possible. In the following paragraphs the common garden vegetables are discussed in more detail.

ASPARAGUS

Asparagus is perhaps the most important of the perennial garden vegetables and one of the earliest and best. The increasing demand for the crop is reflected in the area which has grown from 30,000 acres in 1920 to nearly 130,000 acres today, the leading States being California, New Jersey, South Carolina, Georgia, Illinois, Maryland and Washington. About one half of the asparagus grown for consumption in a fresh state comes from California and practically all of the asparagus grown for canning is localized in the Sacramento and San Joaquin Valleys, California. But while the commercial production of asparagus has become pretty strictly localized in a few truck-growing regions, the plant thrives in almost any part of the country, and any farmer who enjoys clipping off a few plump spears of asparagus in early spring for his own table may easily establish a bed of this crop in the corner of his garden. It is a hardy plant, grows year after year from the same roots, and never fails to produce a crop.

Asparagus will get along on almost any well drained soil, but likes best a deep, rich, loose soil. Good corn land is satisfactory. Light, gravelly soils should be avoided since they will not hold enough moisture for asparagus. In any case, whether a small bed or a sizable planting is decided upon, certain preliminaries are necessary. The soil must be made fertile and put in the best possible tilth. Humus is of vital importance and barnyard manure is probably the best source of that constituent of the soil. Humus is of more urgency than commercial fertilizers except on peat or muck soils where an abundance of humus is present. If manure is not to be had the same effect may be secured by plowing under clover or other legume, or even rye, oats or barley. But the green manuring crop should really be green, not mature or even in the sere. All this preparation should be done the year before the asparagus is planted. After the crop is established about 1200 pounds of a complete fertilizer per acre should be applied either at the beginning or end of the cutting season. Opinions of growers differ as to which time is preferable.

There are many varieties of asparagus, but wherever the rust disease prevails the Martha Washington will do best because it is most rust-resistant.

"For the home garden or a small plant-

GARDEN OF BEANS AND ASPARAGUS

ing it is perhaps best to purchase 1-year-old crowns from a reliable nurseryman or plant grower, but where a large acreage is to be planted it may be advisable for the grower to raise his own plants.

"The first essential in growing crowns is to obtain good seed of the desired variety. The crossing that occurs in the field adds greatly to the difficulty of procuring seed of known quality for planting. Unless special care is exercised in the selection and handling of the seed-bearing and pollen-bearing plants the young seedlings may be somewhat variable. Most asparagus varieties are rather variable at best; hence the importance of good seed of known quality cannot be too strongly emphasized.

"Seed capable of producing high-yielding crowns can be obtained only by the selection of high-yielding parents. High-yielding male and female plants should be selected and isolated in such a way that the selected female plants receive pollen only from the selected males and not from other sources. Seed obtained from parents selected and protected in this way should produce crowns capable of a much higher average yield than seed from unprotected field-grown parents. The importance of good seed from high-yielding parents cannot be too strongly emphasized in the case of a perennial crop like asparagus. Even a small difference in yield per crown resulting from careful selection of seed stock may mean a great deal of difference in profit over the lifetime of the planting."

Female plants have been shown to produce larger spears than male plants but male plants produce a greater number of spears, having a greater total weight than the female. While male plants may be a little more productive than the female, it is doubtful if the grower should make much effort to obtain crowns of one sex for planting. As stated above, 1-year-old crowns are known to be decidedly superior to older crowns, and therefore, since it is impossible to definitely determine the sex in most cases until the second season when flowers and fruit are produced, it seems advisable for the grower to pay particular attention to the selection of large, vigorous 1-year-old roots and leave the matter of sex to chance.

A patch of ground 20 feet square, or a row 75 feet long, will supply enough asparagus for a family of 5 persons. The roots go deep for food and moisture. Therefore for a small family bed it is worth while to spade manure or peat into the subsoil to a depth of 14 to 16 inches. In beds the plants should be 1½ feet apart each way. The crowns are covered about 6 to 8 inches deep. Shallow planting may result in the premature appearance of the spears in the spring before danger of frost is past.

In starting from the scratch with asparagus there is a long wait to be patiently borne. No shoots should be cut the first year and the cutting period should be short the second. In subsequent years all shoots should be removed. Early in July cutting should cease, and the tops allowed to grow until fall when they may be removed and burned. When thoroughly established asparagus beds may be expected to yield profitable crops for 10 to 20 years, and in the northern States the cutting season may cover 8 or 9 weeks.

On the market asparagus is sold in 3 grades: green, green with white butts, or entirely white. The chief fresh market demand is for the green, while most of that grown for canning is white.

Asparagus shoots grow very rapidly, especially if the temperature is high. If not harvested regularly, the spears soon become too old. Early in the season the shoots may require cutting only every third day. As the season advances, however, and the growth becomes more active it may be necessary on very light warm soil to cut twice a day.

The cutting should be done with a knife made especially for the purpose. Green asparagus should be 9 to 10 inches in length, and at least half of the length should be above ground. The underground portion should not be too long, as the lower end is fibrous and less palatable. In cutting care must be exercised to avoid injury to the young spears developing underground. The spears should not be cut too close to the crown, as the undeveloped buds on the rhizome may be injured. Knife injury to buds and unharvested shoots causes them to develop into crooked spears. It is a good practice not to cut closer than 2 inches from the crowns.

Asparagus is afflicted with several diseases, but rust is the only one of much importance. This disease was first noticed in 1896 and has since spread over all asparagus regions. It appears first as reddish-yellow spots on the stems and small branches. Later the entire field may turn brown and the leaves fall. The only effective means of prevention are found in the use of the rust-immune Martha Washington variety, and in de

stroying all the wild asparagus plants found growing around the borders of the field or in the fence rows.

The crop is also subject to injury by the asparagus beetle, a bluish-black beetle with a red thorax, which passes the winter under rubbish and comes out in spring to feed upon the young shoots. Several parasitic and predaceous insects prey upon the pest but never hold it entirely in check. Spraying the mature plants with arsenicals and disposing of all rubbish near the fields helps materially.

BEANS

The commercial production of dry beans has been discussed in its alphabetical position among the field crops. This article is concerned with green lima and snap beans for the farm garden or trucker. From the point of view of the home gardener these are more important than dry beans. Production has increased rapidly of late years reaching 73,000 acres of commercial snap beans with a total crop of 127,000 tons and 79,000 acres of lima beans. These figures of course do not include the areas in home gardens with which we are here chiefly concerned.

In Georgia snap beans, both bush and pole types, are among the most important of all home garden crops. They do well in all parts of the State. If both a bush and a pole variety are planted in early spring, the bush type will be ready for picking 2 weeks ahead of the pole beans, and a second crop may be planted in August while pickings from the pole beans will be available until frost.

Garden beans require a richer soil than field beans. The best is none too good for them. In the north they should not be planted until the ground is warm, but a succession of plantings 2 weeks apart will furnish a continuous supply. In the far south fall, winter and spring are the bean seasons. They are not so well adapted to summer heat. Kentucky Wonder is perhaps the best pole variety, while Stringless Green Pod and Tendergreen are good bush snap beans.

Lima beans require a growing season of about 4 months, and are therefore not adapted to the northern portion of the States along the Canadian border. Lima beans of both bush and pole types are to be had. Pole beans, whether lima or kidney types, require supports, preferably saplings 2 inches in diameter and 6 or 7 feet long. The poles may be set about 4 feet apart each way, and the seed should not be planted more than 1½ inches deep. In California, where large lima beans are still grown in larger areas than the "baby limas" the latter are gaining in popularity. The large limas are confined to a coastal strip 8 to 10 miles wide from Santa Barbara to San Diego Counties. In California red kidney beans are grown largely in the Sacramento and San Joaquin Valleys where they are planted late in June in order to avoid bringing them into bloom during the hot dry weather of August.

The bugbear of garden beans is the Mexican bean beetle, a copper colored beetle about ¼ inch long with 16 black spots on his back, which develops from a fuzzy orange colored larva. This pest first appeared in Alabama in 1920 and has since infested nearly all the country east of the Mississippi. According to the Bureau of Entomology "the best known remedy for the protection of beans is the application of a spray containing derris root powder in water. The recommended derris or cubé powder spray consists of 1½ pounds of powder (containing 4 per cent of rotenone) in 50 gallons of water, or 1½ ounces in 3 gallons. Derris sprays or dusts may be applied after the pods since this product leaves no harmful residue."

Beans may also be afflicted with anthracnose characterized by round sunken spots, blight, appearing as large irregular diseased blotches on the leaves, and rust, to be known by the appearance of red pustules on the stems, leaves and pods. The only good remedy consists in pulling up and burning the plants on which these ailments first appear, in order to prevent further spread.

BEETS

The constant market supply during the winter of freshly bunched table beets has greatly stimulated the use of this vegetable. The combined acreage of beets grown commercially for table use and canning has already passed 27,500 with a production of 2 million bushels for fresh market, and 107,000 tons for canning, New York and Wisconsin being the leading States in the raising of canning beets. For table use the round or half-round types are most in vogue. The common garden beet, sugar beet, chard or leaf beet and mangel are the 4 principal forms of cultivated plants which originated from the wild plant known botanically as *Beta vulgaris*. The sugar beet has been considered in the section devoted to field

crops. The other forms of this plant are discussed briefly here.

Beets are hardy and for the early crop the seed may be sown as soon as the land can be worked in the spring. Fall plowing is best, followed in the spring with thorough harrowing. The rows may be as close as a foot apart. The seed is covered 1½ inches deep and the young plants thinned out to stand about 3 to 6 inches distant in the row. The thinning is deferred till the young beet tops have attained such a size that those pulled up may be used for greens. Beet seed will germinate much sooner if hot water is poured on it and left standing for 6 or 8 hours. Garden beets may be planted any time up to June 1 in the north, but if mature beets for winter storage are desired, they must be allowed the whole season to attain their growth. For the home garden a constant succession of beets may be provided by sowing at 3 week intervals. Early Wonder and Crosby Egyptian are suitable varieties. Whatever manure and fertilizer are to be used should be applied before seeding. Beets are as grateful for well drained, porus and fertile soils as are other garden vegetables.

Chard is a form of the garden beet in which the midrib of the leaves is cooked and eaten as a potherb rather than the root. It is also called Swiss Chard. It is easy to grow. The seed may be sown early in the spring in shallow drills 12 to 16 inches apart. Its requirements for soil, fertilizers and cultivation are the same as for garden beets. The whole top of the plant is tender and may be used as greens, or the midrib may be used alone like asparagus. Late crops may be obtained from seedings up to August 1. "One of the advantages of this crop is that the outer leaves may be harvested from time to time without injuring the plant. Only one planting is really necessary and a row 30 to 40 feet long will supply a family for the entire summer." Chard is sensitive to acid soils and responds to the application of lime.

Mangel-Wurzels. These require about the same soil as field beets. They are planted in the spring as soon as the ground can be worked, in rows about 2 feet apart, to permit of horse cultivation, and thinned to 12 or 14 inches in the row. From 4 to 6 pounds of seed are required per acre. The roots grow much larger than field table beets and are coarser grained, though possessing much the same feeding value. They grow partly out of the ground, and are, therefore, easily harvested. The crops should be pulled before heavy frosts set in. Machinery has been devised for this purpose. The leaves should be cut off to within an inch of the crowns and the roots stored in a cool cellar or in pits in the ground, and covered over with straw and earth deep enough to prevent freezing.

Mangels are exceedingly watery, yet the heavy yields obtained per acre (20 to 30 tons) make them stand well as compared with other roots as regards yield of total dry matter. The Cornell Station found that on similar soil the yield in dry matter of sugar beets and mangels was practically the same, but the cost of harvesting the sugar beets was double the cost of harvesting the mangels. The succulent nature of mangels and beets makes them of use primarily for feeding of cows. They also have a good effect when fed to sheep and to pigs, when boiled and mixed with meal. The chief function in the farm economy is to furnish a palatable, succulent food in winter to supplement the dry hays and grains usually fed, thus keeping the animals in good appetite and form for the more nutritious foods upon which the feeder depends for fattening.

For insects and diseases affecting field and garden beets *see* under *Sugar Beets.*

BROCCOLI

The leading type of broccoli closely resembles cauliflower, is essentially a late maturing strain of cauliflower for which it is often sold. It is somewhat more hardy than cauliflower but requires a longer season for maturing. In the colder parts of the North the season is hardly long enough for broccoli. In the South the plants may be set out in the fall to come to maturity in early spring.

"Sprouting broccoli" according to the Bureau of Plant Industry, "forms a loose head on a branching stalk. It has been familiar to Europeans for many years but is one of the newer vegetables to most American gardners." Cultural methods are the same as for cabbage. It endures hot weather well. Plants set out early in April will yield sprouts in about 10 weeks. The sprouts carrying the flower buds are cut about 6 inches long, leaving other sprouts in the axils of the leaves to permit a continuous harvest.

BRUSSELS SPROUTS

Brussels sprouts is a variety of cabbage which produces numerous small heads in the axils of the leaves ¾ to 2 inches in

diameter. They are cooked like cauliflower and are the most delicately flavored of the cabbage tribe. They are cultivated like cabbage, are more hardy and will live over winter in the milder parts of the country. "As the heads begin to crowd, the lower leaves should be broken off to give them more room. The top leaves are left as they are needed to supply nourishment. For winter use the whole plants may be pulled up and set close together in a cold frame or cellar with some soil tamped around the roots." Dwarf varieties may be surer to mature in localities with a short growing season.

DUSTING BRUSSELS SPROUTS

CABBAGE

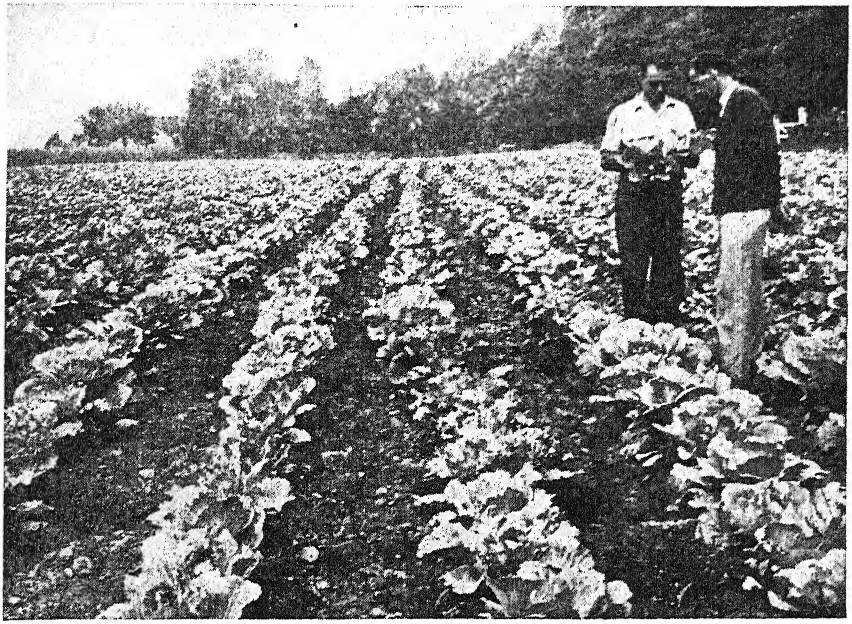
About 160,000 acres are devoted to the production of cabbage for market in the fresh state and an additional 210,000 tons for kraut to satisfy our national hunger for cabbage. The demand requires that the crop be produced the year round. Hence market brokers classify cabbage according to the season when they are received and the region from which they come, into early, second early, intermediate, second intermediate, fall and late. New York and Philadelphia begin to receive Florida and Texas cabbage by New Year's. That early crop keeps on coming till May 15. In the meantime South Carolina cabbage starts coming about April 1 and runs to May 31. Then the Norfolk crop strings along from May 1 to June 30, overlapping the New Jersey cabbage season which runs from June 15 to September 1, to be followed by New York cabbage from September to April or later.

The wide distribution of cabbage is due to its ready adaptability to climatic conditions and to its popularity as a food. It is a hardy plant, easy to grow, and will thrive on any good soil. A loam with gravelly subsoil is generally preferred. It is well to fertilize the ground heavily with well rotted manure up to 30 tons per acre, or even 80 tons in commercial gardening. In the South cabbage does well at all seasons except midsummer. In the North cabbage may be grown either as an early summer crop or a late fall crop for winter storage. Between these extremes of climate it may often be set out in the fall to become one of the early spring vegetables, and in one season or another cabbage thrives in practically every part of the country. The cost of seed is negligible since a few cents' worth will start enough plants for a home garden. Few families need more than 2 or 3 dozen heads of early cabbage per season.

For the early crop Golden Acre and Early Jersey Wakefield are good sorts, for

late cabbage Flat Dutch, Danish Ballhead and Penn State Ballhead are much used.

Planting. For the early crop start the seed about 5 or 6 weeks before the plants will be needed for setting in the field, in a seedbed in the greenhouse, or sow in a hotbed, or even in a shallow box in the kitchen window. Large seed have been found in the Maine Station to produce larger heads than small seed, and at the New York State Station seed from the lower branches of the main stalk gave better results than that taken from the terminal pods. Plant the seed in rows ¾ inch apart, putting 4 or 5 seeds to the inch. Cover ¼ inch deep and press the rows down firmly. As soon as the frost is out of the ground in the spring and the weather gets settled, the young plants should be hardened off by gradual exposure to outdoor conditions, and then set in the field in rows 30 inches apart, with the plants 24 inches distant in the rows. This will permit of horse cultivation both ways while the plants are young. Late cabbage is obtained by planting long growing varieties or early or medium varieties late in the season. The seed for late cabbage is started in a seedbed outdoors. Sometimes the seed is sown in hills where the cabbage is to stand in the field, but on account of insects this method is not generally as satisfactory as sowing in a seedbed and transplanting. It requires about ¼ of a pound of seed to produce enough good plants to set out an acre. Where a succession is wanted the seed may be sown every 10 days or 2 weeks up to the middle of June.



CABBAGE FIELD IN CONNECTICUT

Transplanting and Cultivation. In transplanting take the plants out of the seedbed carefully, so as not to break the fine roots, lay in a basket, moisten thoroughly and cover with a wet cloth to prevent the plants from drying out. Choose a cloudy day for transplanting if possible, and if the soil is at all dry make a hole with a dibber or round pointed stick, not too deep, pour in about ¼ pint of water, put the plant in the ground up to the first leaves, and pack the wet soil or mud firmly about the roots, putting dry dirt on top to prevent evaporation. Plants seldom ever wilt when thus treated, and the method is much to be preferred to planting immediately after a rain.

After setting out, the plants require frequent shallow level cultivation until the crop matures. Too much cultivation cannot be given, and especially after every rain should the ground be thoroughly stirred. A fine-tooth horse cultivator is one of the most satisfactory implements for this purpose. At the Maine

Station mulching the plants with straw or similar material in a dry season tended to increase the size of the head. At the Nebraska Station also a straw mulch was found very beneficial for cabbage.

Storing. When cabbage is grown for market it is generally advisable to dispose of as much of the crop as possible in the fall rather than store over winter. Without proper handling cabbage is liable to rot badly. It should never be put in storage when wet, or handled when frozen. Cabbage is in the best condition for storing when it is not fully mature, and while the heads are a little soft. It keeps well in a cold, damp cellar, stored in shallow bins about 4 feet wide. Another way is to bury the heads in sand or heel them in the cellar. When the crop is stored out of doors the heads should be placed down in long narrow trenches and covered over with straw and dirt deep enough to prevent serious freezing. The secret of storing cabbage successfully is to keep it cool and moist, but not wet. The stumps should always be left on except when the crop is stored in bins.

Another type of cabbage known as savoy is tender of texture and delicate of flavor. The leaves are dark green and finely netted and wrinkled. Savoy is more hardy than common cabbage, but yields less heavily. Among the red or purple cabbages Red Dutch and Rock Red are standard varieties.

Chinese cabbage or pe-tsai, a plant between cabbage and turnip in its relationship, occurs in both heading and non-heading forms. It is recommended for fall culture in the North and winter in the South, in rows about 24 inches apart and 8 to 10 inches distant in the row, to be sown in the North about 2½ months before frost. The non-heading type makes an excellent potherb.

Collard (*Brassica oleracea* var. *acephala*), a kind of cabbage growing 2 to 3 feet high which does not make a hard head. The central leaves often form a loose rosette. These are tender and are used as a potherb like kale. The Georgia collard is widely known and much grown in the South for southern markets. In the North, where heading cabbages are raised, collards are little grown and not highly prized. Young cabbage plants are frequently eaten as greens under the name of collard. Collard seed is started under glass or sown in beds in the open, and the plants handled and cultivated like cabbage plants. In the field the plants should be set in rows 3 to 4 feet apart and 3 feet distant in the row. Otherwise the treatment and uses of collard are the same as for cabbage. They are more popular in the South than in the North, and endure heat better than cabbage. The rosette of leaves may be blanched by tying together.

Diseases and Insects. Cabbage is subject to a rather formidable array of diseases and insect pests which also attack turnips, cauliflower, brussels sprouts, collards and wild plants of the mustard family. The important enemies of these plants are treated in the following account.

CLUBROOT (*Plasmodiophora brassicae*) is common on cabbage and related plants, such as turnips, radishes etc. Affected plants appear sickly and do not form heads. Young plants may be attacked in greenhouses, or infection may take place in the field. Swellings appear on the roots, and in some cases the whole root system becomes one mass of diseased tissue. It cannot be treated by spraying. An application of air-slaked lime at the rate of 75 bushels per acre sometimes gives good results. The disease may remain in the soil for a year or more, and rotation of crops is therefore suggested, with destruction of wild plants of the mustard family, on which the fungus may grow. Diseased roots should be destroyed as well as infected seedlings. Only healthy plants should be set out.

BLACK ROT (*Pseudomonas campestris*) causes a dwarfing or one-sided development of the heads. Badly diseased plants may fail to form heads and die. The parasite probably passes the winter in the soil. Cabbage seed should be planted on uninfected ground, preferably where some other crop was cultivated during the previous year. The disease may be spread by the manure of animals which have fed on diseased cabbages. Insects may also help to carry black rot from one plant to another. Cabbage insects should therefore be destroyed. Wild mustard in the vicinity of cabbage fields should be eradicated.

YELLOWS, caused by a soil-inhabiting fungus, may be recognized by the sickly yellowish-green color of affected plants which often curl up rapidly and die. Crop rotation, or use of such resistant varieties as the Wisconsin Hollander or Danish Ballhead are the best remedies.

The cabbage worm is the young of the common white butterfly that flutters from morning till night over cabbage fields laying its eggs to develop into 2 or 3 broods

a year. These worms industriously eat holes in the cabbage leaves from April to October. The most effective treatment is derris dust containing 1 per cent of rotenone, or pyrethrum powder applied in late afternoon or early morning.

PLANT LICE is the name given to a large group of small insects numbering hundreds of species and attacking all sorts of cultivated plants, herbs, trees and weeds in all parts of the country. Many plant lice lead a double life appearing at different seasons on different host plants, migrating back and forth between hosts. They are mostly the familiar small green insect with or without wings, often occurring in such numbers as to completely cover the surface of the young leaves and fresh shoots of their host plants. Sometimes cabbage plants may be rid of them by a dashing douche from a garden hose or by spraying with nicotine sulphate or soap solutions.

THE HARLEQUIN BUG, a gaudy red bug about ½ inch long spotted with black, is confined chiefly to the southern part of the country from Virginia to California, but often appears farther north. The young may be destroyed with derris extract, 4 tablespoonfuls in 3 gallons of water. But the adults are insecticide-proof and must be hand picked. The eggs are attached to the under side of the leaves and resemble tiny black-banded barrels on end.

CARROT

Within recent years the demand for carrots has been noticeably increased by the investigations of specialists in nutrition who have called attention to this vegetable as an excellent source of carotene, a constituent of vitamin A. Carrots also contain some assimiliable iron. The commercial production of carrots has progressed steadily since 1920 and now covers an area of 50,000 acres, with a total crop of about 18 million bushels, the chief producing States being California, Texas, New York, and New Jersey.

The winter crop comes from California, Arizona and the South, appearing on the market as bunched carrots. New York leads in the production of the main summer crop of carrots.

Although seedmen have used hundreds of variety names, there are about a half dozen varieties that meet all requirements, Coreless, Danvers Half-Long, Chanteny, Morse Bunching and Imperator. The seed supply is raised mostly in California.

The most suitable soil for this crop is a deep, mellow, rich loam as free from weed seed as possible, and put into a fine condition by frequent working with harrow and cultivator.

Culture. For the early crop sow the seed as early in spring as the ground can be worked in rows 16 to 24 inches apart if hand cultivated, and 30 to 36 inches if cultivated with a horse. About 2 pounds of seed are required per acre. Cover the seed about ½ inch deep. It is advisable to mix in a few radish seed to help locate the rows, since carrot seed germinates slowly, and cultivation to keep down weeds is frequently necessary before the young carrots make their appearance. When the plants are well up they should be thinned to stand 2 or 3 inches apart in the row. Frequent shallow cultivation should be given with some light implement throughout the season. Late varieties for stock may be sown the latter part of May or as late as the middle of June in the Northern States. The plant makes its best growth in the cool weather of fall.

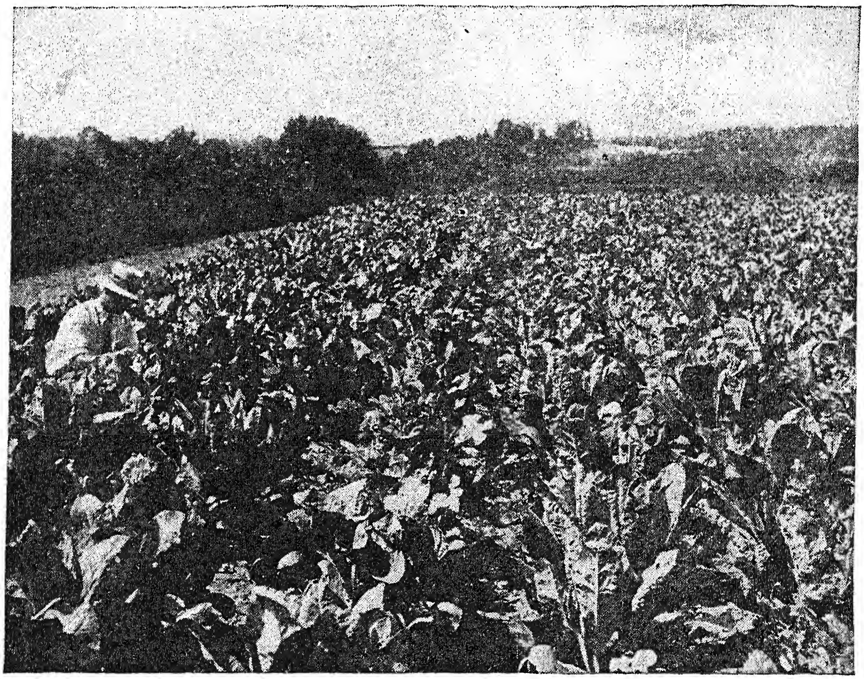
The crop is harvested usually by hand pulling and topping. The work of pulling is often facilitated by running a plow alongside the rows to loosen them. Where the half-long varieties are grown they can frequently be plowed out. From 200 to 300 bushels per acre is a good yield. The roots may be stored in pits or the cellar like potatoes. There is a considerable amount of hand labor to the culture of carrots, which makes their growth relatively expensive.

Use. Besides the use of carrots as a table vegetable they form a favorite succulent food for horses and dairy cows. Foreign experiments show that for stock feeding purposes carrots are about equal to other roots. The Agricultural Experiment Stations in this country have reported but few experiments with this crop as a stock feed. Except for the purpose of variety in the diet it will probably be economy to grow other larger yielding root crops, like mangels or rutabagas.

In the home garden a continuous supply of carrots may be had by successive plantings at intervals of 3 weeks. In Georgia carrots are planted either as a spring or fall crop. Weeds and grass must be kept in check by shallow cultivation since carrots grow slowly and cannot compete with them successfully. The diseases to which the carrot is subject may usually be controlled by spraying with Bordeaux mixture.

CAULIFLOWER

Cauliflower is a rather difficult crop to raise and may require more attention and patience than the home garden can allot. Commercially it is grown chiefly in California, Long Island and other parts of New York, Colorado, New Jersey and Washington. It requires cool weather and will neither head up nor even thrive in the heat of midsummer. Methods of planting and cultivation are the same as for cabbage. In Northern States along the seaboard and Great Lakes it is grown as an early or late crop like cabbage. In Georgia cauliflower does well in the mountains of the northern part of the State during the early spring, and in some localities along the Atlantic coast in winter. By the time the heads are as large as a fifty cent piece they must be protected by gathering in the leaves over the top and tying them together. If dirt or insects are allowed to enter, the heads will be discolored, and if the heads are exposed to the sun they will not develop at all or will turn brown. Cauliflower has the same preferences in soils and fertilizers as cabbage. The heads do not keep well after reaching full size and therefore cannot be stored like cabbage.



FIELD OF CAULIFLOWER

CELERY

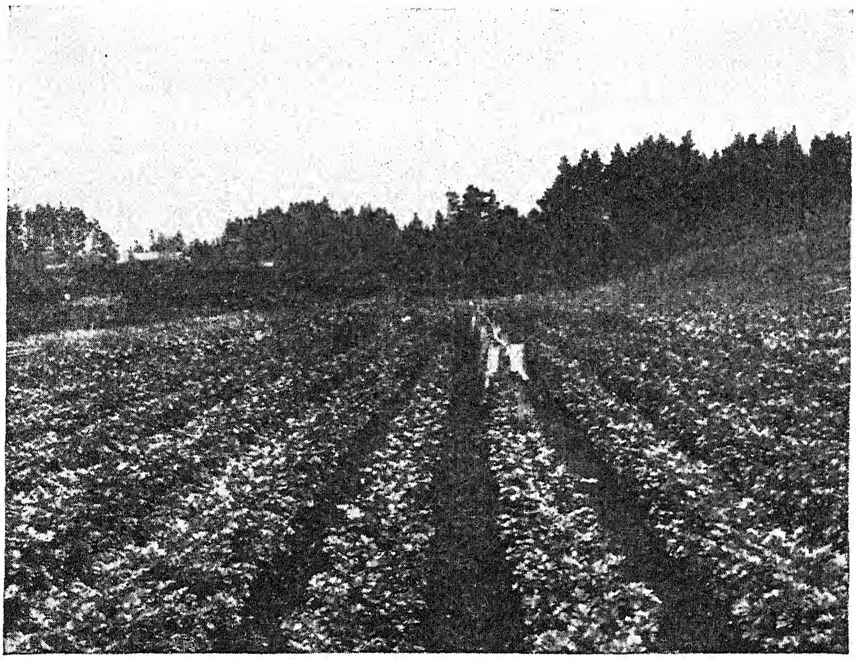
Celery is the cultivated and improved form of a wild plant (*Apium graveolens*) that grows on marshlands from Sweden to the Mediterranean. It is closely related to caraway, parsley and anise and in common with them possesses a characteristic odor due to a volatile oil which develops in all parts of the plant but particularly in the seed. In the hands of plant breeders celery has undergone great transformations and now appears commercially in two forms, the yellow and the green. The standard variety of the green type is the Giant Pascal of large size, late maturity and an excellent keeper. It is tender and savory but difficult to blanch. Of the yellow type Easy Blanching is hardy and quite resistant to blight, and Michigan Golden is resistant to fusarium disease. The County Agents of the Agricultural Extension Service should be consulted as to varieties best suited to particular localities.

Celery is a hardy plant and will grow in almost any part of the country and on any type of soil, but large commercial developments have taken place on special kinds of soil. In the Great Lakes region black muck soils are preferred like those

in the familiar celery area around Kalamazoo. In the Sanford area of Seminole County, Florida, celery is grown in fine sand soil. The river bottom lands of Sacramento and San Joaquin Valleys, California, provide an alluvial soil to which celery seems perfectly adapted.

Celery is not only insistent on cool nights and sunshiny days but must have abundant moisture. In the far west dependence is placed on irrigation. Rainfall is usually adequate along the Great Lakes. But on the muck soils of that region provision is made for raising the water table in the deeper layers of the muck if rainfall should fail at critical seasons. Overhead sprinklers serve the same purpose in New Jersey and elsewhere. In the porous sandy soils of Sanford, Florida, an elaborate system of subirrigation has been in use for many years, whereby an underground water supply is kept constantly at a level just within reach of the roots and can also be prevented from rising too high. In Michigan subirrigation through 2-inch drain tiles has been satisfactory. Celery may require 4 or more irrigations but it pays to apply the water. The crop may be more than doubled thereby, and the stalks are likely to be rendered more crisp and tender.

In the early years of the celery industry this crop was looked for on the market only during the fall and early winter. But the wide extension of its commercial production into other regions has spread the supply of fresh celery over the whole year. California covers practically the 12 months. New York and Michigan celery is in greatest evidence from June to January, while Florida fills in the gap from January to June.



CELERY FIELD IN OREGON

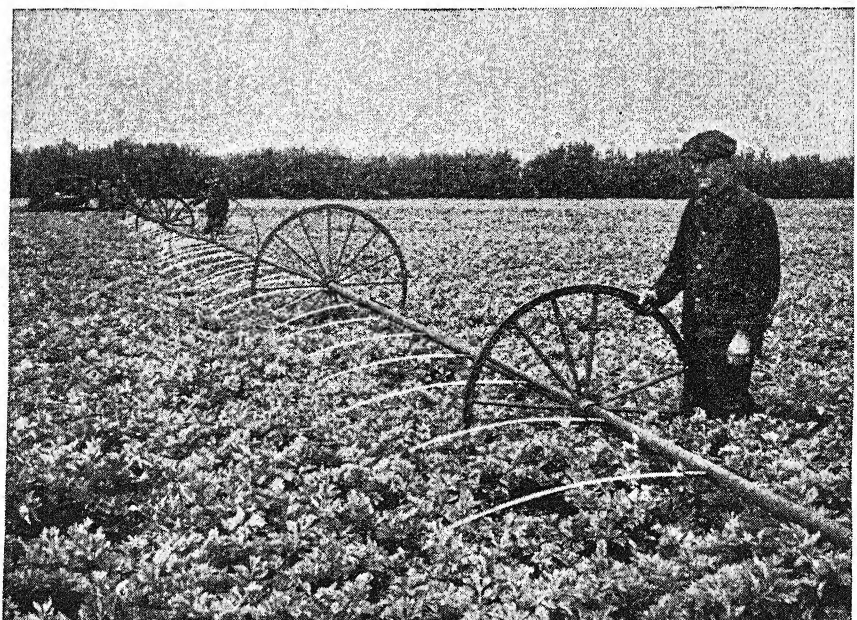
The kind and quantity of fertilizer to be applied depends naturally on the soil. In the sandy soils of Sanford, Florida, which are almost devoid of plant food, fertilizer is applied up to 4 tons per acre during the season. In that region nitrogen and potash seem to be more urgent than phosphoric acid. Barnyard manure used to be heavily relied upon for celery growing along with wood ashes. The soil can hardly be made too rich in these elements for celery. Thirty tons of manure per acre is about right if it can be obtained. For the home garden a combination of manure and commercial fertilizer is usually possible. The fertilizer value of wood ash varies according to its origin and preservation. If it has been leached with water a part of the potash has been lost. And the percentage of potash in

hardwood ash, (maple and oak) is much higher than that from soft woods. As much as 1000 pounds per acre of wood ash may safely be plowed under in preparing ground for celery.

Early Celery. For the early crop in the Northern States the seed should be sown in February or March in shallow boxes filled with loam and kept in the greenhouse, hotbed, or even in the kitchen window. The seed are scattered broadcast and a little sand sifted over them. One ounce of seed will produce from 3000 to 5000 plants. The seed germinates slowly, requiring from 12 to 14 days. During this time the soil should be kept moderately moist. As soon as the plants are large enough they should be pricked out into other boxes or into a hotbed, putting them an inch apart in rows 3 inches apart at the first transplanting, and 2 inches apart in rows 4 inches apart if a second transplanting is made. In pricking out shear or pinch off a portion of the tops and cut back the roots to induce a stocky growth. The plants should be hardened off and set in the field as soon as the weather permits, which will be some time in the second half of April. Set the plants in rows 4 feet apart and 6 to 8 inches distant in the row. The same care in setting will be required as for cabbage plants. During the season they will require thorough shallow cultivation. The stalks may be blanched by setting a tile over each plant, wrapping it with paper or setting up boards along the sides of the rows to exclude the light. Banking the rows with earth is not generally practiced with early celery, since the hot weather of summer usually induces rot. The so-called self-blanching varieties of celery, as Easy Blanching, are the ones best adapted for the early crop.

Late Celery. The main crop of celery is grown in the fall. Seed for this crop should be sown in a thoroughly pulverized seedbed outdoors in shallow rows about 8 inches apart and the rows firmed down with a hoe. In the South the North Carolina Experiment Station recommended for the seedbed a moist border shaded from the south sun by a board fence. The seedbed must be kept moist at all times. Sometimes this is accomplished by putting old bagging over the bed and watering the bed through this. As the seed begin to sprout the bagging is propped up over the plats on stakes until the plants are well rooted, when it is removed altogether. A lath screen is sometimes used for the same purpose. When the plants are about 2 inches high they should be thinned to stand 2 inches apart and the tops sheared off to induce stockiness.

Most of this discussion is with the



IRRIGATING CELERY IN NEW YORK

needs of the home garden in view. Commercial growers have, of course, greatly mechanized the processes wherever possible. In recent years, as growers have found the cost of lumber and tarpaper supplies skyrocketing in price, and the cost of labor for banking the rows with these materials also rising, they have had recourse to closer planting, so close that the celery foliage shuts out the sun and shades the stalks sufficiently to blanch the early crop of the easy blanching varieties to meet market requirements. For more complete blanching of the later crop, in rows not to exceed 34 inches apart, strips of the paper specially prepared for the purpose may be placed along each side of the rows and held in place by wire fasteners, as has long been in practice in Florida.

Celery is attacked by many enemies. Botanists distinguish between 4 kinds of leaf blight which appear as spots and discolored blotches on the leaves and stalks. It is probable that all these troubles are carried in infected seed. The seed may be disinfected by soaking for 30 minutes in 1 to 1000 solution of corrosive sublimate in water, after which the seed is to be rinsed and dried. Always use care in handling this chemical since it is a deadly poison.

Root knot of celery is caused by minute thread worms, or nematodes, which attack the roots. If they become generally distributed through the fields they furnish a difficult problem to deal with. Seedbeds may be sterilized with steam or by applying calcium cyanamid, or by pouring 2 ounces carbon bisulphid in holes 8 or 9 inches deep and 18 to 20 inches apart through the fields. But this is an expensive, inflammable and exceedingly disagreeable remedy to apply. Against most of the celery diseases plant breeders are gradually producing more or less resistant varieties. Inquiry should be made on that point before buying celery seed. Crop rotation is also to be considered.

The celery leaf tier is a small pale-green caterpillar, the young of a yellowish-brown moth. The caterpillar ties the leaves together by means of webs and eats into the heart of the plants. The pest may be controlled by dusting "with a mixture composed of equal parts of pyrethrum powder and tobacco dust. Watch for the first appearance of the larvae and blow the mixture into the crowns of the plants. Repeat the application in half an hour to kill the worms forced from their protecting webs by the first application."

Celeriac is a form of celery in which the root rather than the stalk is the edible portion. It is enlarged like that of the turnip, and is used either as a salad or a cooked vegetable. The seed is sown and the crop is cared for in the same manner as celery, except that blanching is not required. The plants do best when transplanted. They should stand 6 to 8 inches apart in the row, and the rows be spaced far enough apart to admit of easy cultivation. The roots may be stored and kept over winter like turnips.

CHICORY (*Chichorium intybus*)

Chicory is grown in a few places in this country primarily for its root, which is roasted and used as an adulterant of coffee. In many places the plant has become a weed. The young leaves of chicory are sometimes used like spinach, and in Europe the tender young roots are

CHICORY ROOTS AND LEAVES

a, Schlesische variety; *b*, Brunswick and Magdeburg varieties (one-sixth natural size)

used as a vegetable, like carrots. The root of the chicory plant is on the order of the beet or salsify root. The plant grows 2 to 4 feet high and bears pretty blue flowers on straggling almost leafless branches. It is only within the last few years that the plant has become agriculturally important in this country in Michigan, Illinois, Nebraska and Wisconsin. Previously the root was imported almost entirely from Europe.

Experience has shown that chicory is adapted to any good loam soil which will produce good root crops, and that it will thrive wherever the sugar beet does well. The most satisfactory fertilizer is well rotted stable manure.

Soil Preparation. Land for chicory should be deeply fall plowed. If this cannot be done, the earlier it is plowed after suitable weather comes in the spring the better. The seedbed should be well harrowed and worked down to pulverize all lumps and make it compact, and again harrowed just before the seed is sown to kill all germinated weed seed.

Planting. The seed may be sown after the weather has settled and the ground is warm. In Michigan and Nebraska, where most grown, this occurs about the middle of May. The rows should be from 18 to 24 inches apart if horse cultivation is intended and from 12 to 14 inches apart if the crop is cultivated by hand. From 1 to 1½ pounds of seed will be required per acre. It is best put in with a garden drill and should not be covered at most more than ¾ inch deep, and in heavy or wet soils not more than ½ inch deep. Should a heavy packing rain come before the seed is up it will often be necessary to break up the crust by running over it a very light spike-tooth harrow made by driving wire nails through a wooden frame so as to project about 1½ inches.

Cultivation. After the plants are up they will need frequent shallow cultivation with some of the light cultivators made especially for sugar beets and chicory to kill the weeds and preserve the soil moisture. When the plants have attained a height of about 2 or 3 inches they should be thinned out to stand from 4 to 6 inches apart. Only 1 plant should be left in a place.

Harvesting. In harvesting the crop a beet loosener may be run along the rows. This breaks the connection of the roots with the soil so that they can easily be lifted by hand. A less convenient way is to run a plow along side the rows so as to expose the roots on one side. Special machinery has also been devised for pulling the roots. After removal from the ground the tops are cut off at the base of the bottom set of leaves. The crop is usually ready to harvest by the first of October. Chicory should not be pulled until the roots are ripe, and this is indicated by the disappearance of the milk from the roots.

The roots cannot endure freezing and thawing without rapid decay; therefore the crop should be harvested before freezing weather sets in. When it is desired to keep the roots some time before delivering to the factory they may be stored outdoors in piles 4 to 5 feet wide at the bottom and covered at first lightly with straw and earth, and later deeper to prevent freezing. The ridges of the piles should be left open for a few days to let the warm air escape.

Endive (*Cichorium endivia*), a plant closely allied to chicory, is much grown as a salad plant by northern gardeners. The fringed-leaved varieties come upon the market in fall and winter from California and Texas, and the broad-leaved sorts are shipped in from southern truck crop regions green or blanched, sometimes under the trade name escarole. Endive requires about 50 days to mature. It may be blanched by tying the leaves up, but the hearts rot badly in hot, wet weather. In Vermont it was found that "endive may be sown early in cold frames or in the open ground like lettuce. Sowing may also be made during the summer, but plants grown in hot weather are of inferior quality. Fall plants may be taken up with a good supply of adhering earth and stored in a dry cellar for winter use." Endive has about the same soil and climatic requirements as lettuce.

CORN SALAD (*Valerianella olitoria*)

This salad plant is also known as lambs' lettuce, fetticus and vetticost. It may be sown in the spring at the time and in the same manner as lettuce, or handled in the fall like spinach for early spring use. It requires 60 to 65 days of good growing weather to mature. The plant is sometimes used as a potherb, being prepared and eaten like spinach, but is usually eaten green as a salad. It is considered valuable chiefly as furnishing a diversity and a succession with mustard and cress, with which it is sometimes mixed. It is less crisp and milder in flavor than cress. It is easily grown and has no special enemies.

CRESS

There are many kinds of cress all characterized by a more or less pungent taste. They are used in salads and for garnishing dishes. The principal cress grown in this country is water cress (*Nasturtium officinale*). This is grown in almost any ditch, shallow stream or moist earth, and often under benches in greenhouses. It is a perennial and is propagated by scattering either seed or freshly cut stems where the plants are wanted to grow.

The common garden cress (*Lepidium sativum*) or, as it is often called, pepper grass, should be sown thickly in drills every few days if a succession is wanted. It is less pungent than water cress. A winter supply can be had by growing in flower pots or boxes kept in a warm place.

Upland cress (*Barbarea vulgaris*) is similar in character and appearance to water cress. It is a biennial and easily grown from seed.

CUCUMBER (*Cucumis sativus*)

Cucumber is a garden crop which is extremely sensitive to cold and to the attacks of the cucumber beetles. The planting, care and cultivation of the crop must be planned with particular reference to those two points. The soil should be fertile and mellowed by plowing or spading to a depth of 10 inches. The seed should not be planted till the second half of May in the Northern States, or until the ground is warm and all danger of frost is past. In home gardens cucumbers are usually grown in hills 5 to 7 feet apart each way. Place a shovelful or two of manure under each hill and cover with 2 or 3 inches of soil so that the seeds do not touch the manure. Ten to 12 seeds to each hill is the rule, covered 1 inch deep with soil mixed with sand to prevent caking, since the young plantlet may not be able to come through the crust. The plants in each hill are thinned out later to the 2 or 3 most vigorous ones. Meanwhile, and at all times, the gardener must be on the lookout for the striped cucumber beetle, a yellow beetle ¼ inch long with 3 black stripes along the back. He winters over in the soil and is waiting for cucumber plants in the spring, not only eating the leaves but also spreading several wilt diseases. From the start the young plants must be protected by frames, a barrel hoop will do, covered with cheese cloth or mosquito netting, the edges of the cloth being weighted

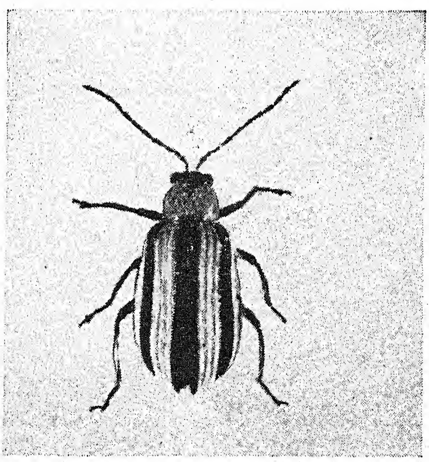
PICKING CUCUMBERS IN FLORIDA

down with soil to keep pests out. The hills may be uncovered for cultivation but should be again covered at once. As soon as the vines begin to run they must be left uncovered for the rest of the season. The labor involved in such constant attention is not great since a dozen hills will furnish enough cucumbers for the ordinary family.

For table use and market cucumbers should be gathered when full grown but still green. For pickling the vines may be picked over every other morning as long as cucumbers are wanted. No cucumber should be allowed to ripen seed, for with the ripening of the seed the vines begin to die, while if the cucumbers are kept picked off, the vines continue to bear for a long time. In large plantings from 100 to 500 bushels per acre are obtained.

Cucumbers are raised commercially on about 42,000 acres for the fresh market, and on over 100,000 acres for pickling, with a production of 7 to 8 million bushels annually, the leading States being Florida, South Carolina, North Carolina, New York, New Jersey, Ohio for the fresh market, and Michigan, Wisconsin, Indiana, Texas, North Carolina and Maryland for pickling.

Cucumbers are second only to tomatoes as a greenhouse crop, the centers of this industry being the same as for tomatoes. In greenhouses it has been found necessary to sterilize the soil with dry steam to prevent the undue prevalence of diseases. Barnyard manure has always been considered an essential in growing cucumbers but the supply is dwindling and the cost is increasing.



STRIPED CUCUMBER BEETLE

Enemies: Since Cucumber Beetles, both the striped and the spotted, perhaps come first in the list of pests one should be prepared to keep the plants covered in cages till they begin to run and then spray with 2-4-50 Bordeaux mixture, and calcium arsenate, which should take care of the beetles and the wilt diseases which they carry.

The Melon Aphis sometimes appears in great numbers on the lower surface of the plants and may kill them outright by sucking out the sap. This pest is controlled by the use of nicotine dust or spraying with nicotine sulphate.

Pickle Worms in their early stages bore into the buds and stems of cucumber plants and later into the fruit. Dusting with a derris and sulphur mixture containing 1 per cent of rotenone is an effective remedy.

CUCURBITS (*Cucurbitaceae*)

This is the general term applied to a large family of plants, including such vegetables as cucumbers, squashes, pumpkins, melons, etc. For the culture and use of these different vegetables see under their common names. The commonly accepted notion that these plants cross with each other when planted together is without foundation. Cucumbers do not spoil muskmelons when these crops are planted together, neither do pumpkins contaminate watermelons. The results of cross-fertilizing experiments with these plants go to show that if there is any immediate effect whatever of the foreign pollen it is not discernible in the form, color or shape of the fruit or seed. The belief that new or fresh cucumber, squash and melon seed tend to produce plants which run to vine rather than fruit, was also found to be erroneous by the New York Cornell Station. The muskmelon was grafted on the watermelon, and both of these on the cucumber by the station. The staminate flowers usually appear 5 or 6 days earlier than the pistillate flowers on these plants, and are from 6 to 24 times as numerous.

DANDELION (*Taraxacum officinale*)

The dandelion, a perennial and troublesome weed in lawns and fields and occurring abundantly in all parts of the country except the South, is frequently gathered for greens and is much prized for that purpose. The root is also used for medicine. Near some of the larger cities improved varieties are grown commercially. The seed are sown in the spring in rows 12 to 18 inches apart and covered ½ inch

deep, about 3 pounds being required to sow an acre. The seedlings are thinned to stand a foot apart in the row. The crop is gathered the following fall or spring and marketed like spinach. Sandy loam soil is best suited for the crop. The plants may be partly blanched by the use of boards or other covers. If cultivated for medicinal purposes the roots may be dug in the fall of the second season. The yield is sometimes as high as a thousand pounds per acre, but the demand for the product is very limited and the grower runs the risk of seeding adjacent land with a most undesirable weed.

DASHEEN (*Colocasia esculenta*)

Dasheen, a plant of the arum family, to which belong the calla lily and jack-in-the-pulpit, with broad leaves resembling those of caladium or "elephant ear" and large starchy roots or corms weighing from 1 to 10 pounds, is a standard food crop among Polynesians from New Zealand to Hawaii, where it is known as taro. A strain of this Oriental taro was introduced into Florida in 1913 under the name dasheen where it is now cultivated in considerable acreage. In Hawaii some 50 varieties of taro are commonly grown, classified by color as pink, white, and yellow or grouped from the cultural standpoint as upland, and irrigated taros. The upland taro is grown without irrigation, while the irrigated taros are raised in the same manner as rice, the land being submerged for the most of the crop season.

These vegetables are of tropical origin, do best in frost-free regions, and must have at least a 7-month season for maturing. In Hawaii the stems may be cooked as a green vegetable, the young blanched shoots may be eaten like asparagus, but the tubers are the product for which taro is raised. These tubers are eaten boiled like potatoes or baked into taro cakes, and a large variety of culinary confections, but chiefly in the form of poi. Poi is one of the universal foods of the Polynesians. It is easily prepared from taro by boiling the tubers and mashing them with the addition of water into a smooth sticky paste which is either eaten fresh or is allowed to ferment.

The dasheen of the South requires a rich, moist soil like those of the hammock lands of Florida. Small tubers of 2 or 3 ounces' weight are used for planting, to be covered about 3 inches deep, 2 feet apart in rows 4 feet distant. They may be planted in February as far north as the coast of South Carolina. By midsummer the leaves may reach a height of 5 to 7 feet and harvesting of the earliest tubers may begin in September.

A great variety of table foods have been prepared from dasheens and taros. The tubers have also been used as a source of starch, stock feed and industrial alcohol and in the preparation of a flour which has been used in making bread, pancakes and crullers.

EGGPLANT (*Solanum melongena*)

This vegetable is grown commercially only in the South, the northern border being New Jersey and Long Island. Farther north the crop is not certain and is grown only to a limited extent for home use. Its culture is similar to that of the tomato, except that it requires a much longer season to mature.

The plants should be started under glass and should be at least 6 or 8 inches high and vigorous when set in the field. Transplanting to the open field should not take place until the soil is warm and all danger from frost is past. In the North this will be from June 1 to 15. When only a few plants are wanted it will be better to buy them. Ten or 12 plants will be sufficient for a large family. The plants are best handled in 2-inch or 3-inch pots as they then suffer no check when transplanted to the field. The secret of growing eggplants is to use vigorous, thrifty plants and keep them growing. Any check to growth is exceedingly difficult to overcome and invites failure.

The plants require a warm, sunny exposure and thrive best in a rich, loamy soil that is fairly dry. Manure heavily. Set the larger growing varieties about 3 feet apart each way and the smaller varieties a less distance. Cultivate thoroughly throughout the season. Only the earlier varieties should be grown in the North. The fruits may be used for cooking from the time they are ⅓ grown until maturity. Of the different varieties Black Beauty and Florida High Bush are most raised.

Diseases: ANTHRACNOSE (*Gloeosporium melongenea*) appears as a shallow pit on the surface of the fruit which becomes marked with small pink specks. The standard fungicides will control the disease. (*See Spraying.*)

BROWN ROT. See under *Potato*.

DAMPING OFF. See under *Cucumber*

LEAF SPOT (*Phyllosticta hortorum*) is recognized as brown or grey dead patches on the leaves, which are covered with black specks. Shrunken patches also ap-

pear on the fruits. The disease may be controlled by rotation of crops, mulching with hay, and repeated applications of Bordeaux mixture.

SEEDING STEM BLIGHT (*Phoma solani*) causes a shrinking of the stem near the ground, with death of the tissue and falling over of the stem. Slightly affected plants may live for some time but make poor growth. The best treatment consists in spraying the soil and bases of the stems with Bordeaux mixture.

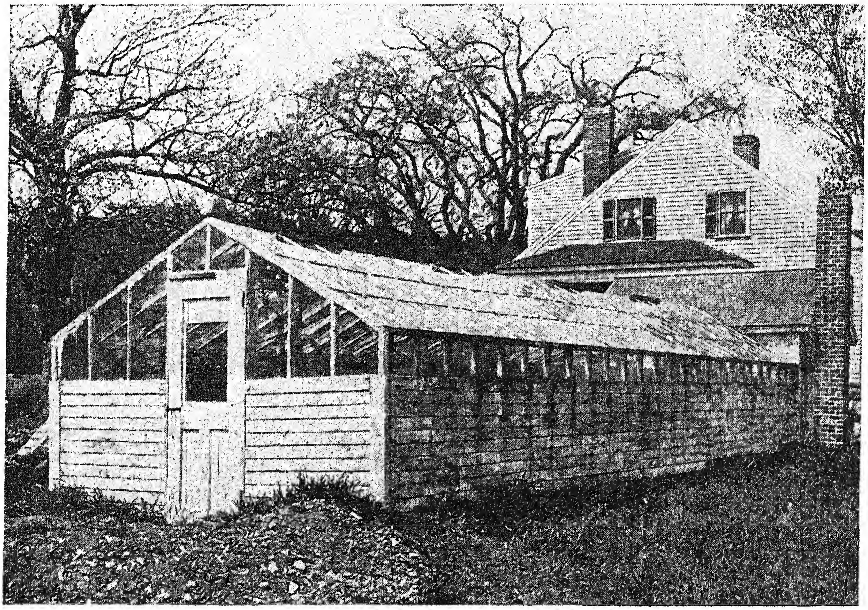
GREENHOUSE

This is a general term applied to all glass houses in which plants are grown or kept green, except hotbeds and cold frames. A house for the display of plants is called a conservatory; for the culture of tropical or semitropical plants, a hothouse or stove; for growing vegetables and fruits out of season, a forcing house, etc.

The principles of greenhouse construction, heating and management are complex and technical. Consult the horticulturist of your State Experiment Station.

HERBS

The use of aromatic herbs and drug plants goes back in history to the beginning of cookery and medicine. Some of them have been cultivated in home gardens since early colonial days, but when the large importations of these plants, which have hitherto come from Europe, are cut off more attention is being given to their cultivation. Most of them are easy to raise and require no special care. Such familiar herbs as anise, lemon balm, sweet basil, borage, caraway, catnip, coriander, dill, fennel, sweet marjoram, mints, sage, savory, tarragon, and thyme are cherished by many a housewife who finds place for them in the corner or border of the flower or vegetable garden. When mature they are cut and hung up in an attic or dry store room, where they may be drawn upon when a special culinary seasoning is desired.



GREENHOUSE ON TRUCK FARM

Some 800 or more native American plants have been used for medicinal purposes, some of slight or doubtful efficacy, others of known value and recognized in the pharmacopoeia. Wintergreen and cascara are among the latter. Boneset, burdock, cherry bark, mayapple, pennyroyal, tansy, valerian and elecampane suggest themselves as a part of the battery of grandmother's remedies for family ills. Many of these plants meet with little demand, but for some of them the consumption runs up to 50 tons or more yearly.

Not only is there an increasingly active interest in the collection of native medicinal plants, a pastime which the farm boy

may find interesting for his leisure hours, but many native and introduced plants are under cultivation on a considerable scale, notably peppermint, spearmint, ginseng, belladonna, henbane, horehound, digitalis, sage, stramonium, etc. The cultivation of these plants with any hope of financial reward requires a connection with a dealer or wholesale pharmacal company in order to learn the market demand, the part of the plant used in extraction of the active drug principle and the stage of growth at which the crop should be harvested. Such details are quite beyond the scope of this article.

California, Oregon, and Washington, nearly half of the acreage being in Indiana.

Over an 11-year period in Indiana the average acre yield of oil was 18½ pounds, while in Oregon the yield reaches as high as 40 pounds, but a variation from 10 to 60 pounds per acre has been reported.

Peppermint is most profitably cultivated on muck soils or reclaimed swamp lands. It is propagated by means of running rootstocks known as "roots." These are from ⅛ to ¼ inch in diameter and 1 to 3 feet long. The ground should be fall plowed and cultivated. In the spring it

DRYING PEPPERMINT

Peppermint and ginseng, however, have enjoyed so much publicity that the methods and extent of their culture should receive attention. Peppermint and peppermint oil have been used in medicine for 1500 years or more. The first distillation of the oil in the U.S. was reported from Wayne County, New York, in 1816. Since 1860 the crop has been raised in Indiana and adjacent States. The peak of production in the U.S. was reached in 1930 when over 55,000 acres were in cultivation. The present acreage is about 33,000 located in Indiana, Michigan, Ohio,

should be cultivated again and rows marked off 2½ to 3 feet apart. The "roots" are laid in these rows practically end to end so that there is a continuous line of roots, and kicked in with the feet. The roots are planted about the time corn is put in. An acre of plants will furnish enough roots to plant 8 or 10 acres, and a man will set about an acre a day. On large farms the roots are put in by a mint planter. The new plants appear in about 2 weeks after setting. Mint requires constant cultivation to keep down weeds. The crop is cut with a mower or by hand

with a scythe when first in bloom, allowed to cure like hay, then raked into rows or heaps and drawn to the still. Where the season is long 2 cuttings can be secured the same year. The ground is plowed to the depth of 6 inches each fall and the crop comes on again without resetting. The second and third year crops are considered most profitable.

The oil is extracted by distillation. The plants are placed in a large vat with a perforated false bottom and steam run through it for 35 minutes to an hour. The oil, being volatile, is carried out with the steam into a long worm condenser cooled with water. It is collected in vats and the oil readily rises to the top and is drawn off.

According to some recent experience, young plants which start up in early spring from runners in old established fields may be used for new plantings. This plan makes it possible to plant late enough in the spring to avoid the ill effects of cold weather.

Spearmint, in addition to being cultivated everywhere in gardens for use in preparing meat sauces, salads, soups and stews, and for mixing with liquors, is also cultivated and distilled for its oil like peppermint, but there is less demand for it. It is easily grown in home gardens from the rootstocks and persists from year to year with little care.

Ginseng (*Panax quinquefolium*) is a native plant which grows wild in woodlands from Canada south to Alabama and westward to the Mississippi. It has long been a standard item in the list of medicines of the Chinese herb doctor, and for more than a century we have been exporting ginseng to China, during the past decade to the value of about a million dollars annually. At first it was a matter of collecting the roots of the wild plants but the assiduity of collectors and the gradual diminution of its natural woodland, nearly exterminated the wild plant and furnished an opportunity for a few experienced and well located growers to engage in ginseng production as a cultivated garden crop.

This plant is a perennial herb 6 to 24 inches high. A main stem the size of a lead pencil is sent up from the root each year which bears at its top from 1 to 4 (usually 3) compound leaves, in the axil of which is borne a flower stalk 2 to 5 inches long. From 12 to 100 bright red berries, much resembling in appearance dogwood berries, are borne on this flower stalk. The root is spindle or carrot shaped, varies in size from ⅛ inch in diameter to 1 inch or more when 5 or 6 years old. The weight in the latter case may reach an ounce or more.

The plant is propagated from seed planted in the fall. The seed gathered in July, if sown in the fall, may germinate the following spring, but as a rule it lies in the ground 18 months before germinating. The germinating power of the seed is destroyed if they are allowed to dry out. It is usual, therefore, to stratify them in moist soil in the fall the same as nuts. The seed should be put in boxes with alternate layers of moist sand and the box buried in the open ground over winter and summer, and the seed planted the fall following.

Plantations of ginseng may be made in the natural woods or in cultivated ground. In the latter case artificial shade must be provided. In its natural state ginseng develops best on east and north hillsides and generally in dense shade. It prefers a rich soil inclining toward a sandy loam. When plantations are made in the woods the underbrush should be cut out and soil dug up to a depth of 6 inches, removing all surface roots. After planting, a thin layer of leaf mold is spread over the seed, and they are left alone until they come up. The crop requires no other cultivation than the removal of the weeds and the subsequent gathering of the crop.

The roots develop slowly and should not be gathered before they are 5 or 6 years old. They continue to increase in size until about 10 years old, when the main root begins to grow woody and finally sloughs off, leaving a younger root in its place. Nearly every root produces 2 or 3 stem roots, which spring from the rootstock near the crown. If these are carefully removed and transplanted they develop into as good roots as though grown from the seed. This method is frequently employed in starting a plantation from wild roots, and when cultivated plantations are dug over these smaller roots are saved out and transplanted again, and only the larger roots sold.

When a plantation is started on cultivated open ground the soil should first be made rich with leaf mold or well-rotted barnyard manure. The seed should be planted as noted above, or may be planted close together in a seedbed and afterward transplanted when 1 or 2 years old. Successful growers in New York cover their entire plantation over with a screen to afford shade. This is conveniently made of lath spaced about as far apart

as the lath is wide. The screen should be 4 or 5 feet from the ground for convenience in working. In the partial shade of this screen the plants grow well.

Blight is one of the worst ginseng diseases and affects leaves and stem, appearing as brown canker spots. It may be controlled by 4 applications of Bordeaux mixture, spaced through the season. Ginseng is also attacked by damping off, root rot, mildew and nematode worms, for the control of which it is wise to call for the advice of the plant pathologist of the State Experiment Station.

HORSE RADISH (*Cochlearia armoracia*)

This plant is grown for its pungent root, which is grated and mixed with vinegar as a relish for meats, oysters, etc. It is a hardy perennial but in commercial culture is grown as an annual. It is frequently seen in out-of-the-way places on old homesteads, where it grows without attention, furnishing an indifferent supply of branching woody roots of poor quality. This is not the way to grow horse radish.

The crop grows best on rich, cool clay loams. It never produces seed. It is propagated commercially by 3-inch to 7-inch cuttings of the small side roots. These are saved from the trimmings when the roots are dug in the fall for market. They are tied up in bundles and preserved over winter like the marketable roots in a cool cellar or pit. The horse radish root makes its best growth in the cool weather of fall, hence there is no hurry in setting the root cuttings out in the spring. They are frequently set in the rows of early cabbage, radishes or beets, and when these crops are removed the ground is given up to the horse radish.

The cuttings are set top end up 2 to 5 inches below the surface of the soil. They may be set perpendicular, slanting or horizontal, and will give about the same results by all 3 methods. The rows should be 2½ feet apart to admit of horse cultivation and the cuttings 10 to 12 inches distant in the row. The plant will stand considerable abuse, and if the leaves appear above the ground before the other crops are removed they may be cut off 2 or 3 times without injury. After the cabbages or beets are harvested 1 cultivation is usually sufficient before laying the crop by, since the plant grows rapidly and its broad leaves soon cover and shade the ground, keeping down weeds.

The growing roots are of inferior quality and should not be dug at the earliest before September. The later in the fall they are dug the better the quality. For home use the roots may be left in the ground over winter and dug whenever needed, but commercially they are dug in the fall, the side roots trimmed off and saved for next year's planting and the marketable roots stored where they will not dry out, either in a cool cellar, or better still, in pits.

In order to produce well-shaped roots without side branches commercial dealers may lift the sets twice during the season to rub off all the small roots except the bottom ones, replacing the sets after the operation.

For home use 8 or 10 plants will usually be sufficient for a large family. They may occupy a plat 3 by 6 feet or fill out a row of rhubarb in the garden and treated as a perennial. The roots thus produced will be irregular, unmarketable and of inferior quality, but there is no trouble in growing the crop. More satisfactory results will be obtained by treating the crop as an annual and setting out a few cuttings each spring. The increased value of the crop will more than repay the increased trouble in growing. Horse radish is seldom troubled with insects or fungus pests.

Enemies: Leaf Spot (*Septoria armoraciae*) causes the leaves to turn yellow, with the formation of numerous holes. Horse radish is sometimes attacked by leaf blight and leaf mold. If these diseases become so serious as to require treatment they may be checked by Bordeaux mixture.

Flea Beetles are often injurious to the leaves. For treatment *see Flea Beetle.*

HOTBED

Hotbeds are low glass-covered frames or boxes in which plants are grown by the aid of artificial heat. By the use of the hotbead many plants may be started considerably in advance of the usual time of seeding outdoors and the earliness of the crops thus greatly advanced. Radishes and letture are often grown to maturity in the hotbed before they can be sown outdoors, and cabbage, tomatoes, eggplant, etc., are usually started in hotbeds and transplanted to the open field when the weather permits.

Hotbed frames are usually made of inch boards. If the boards on the back of the frame are 15 inches wide those in front should be 10 to 12 inches wide. This will give a slant to the sashes, so that water will run off quickly and permit

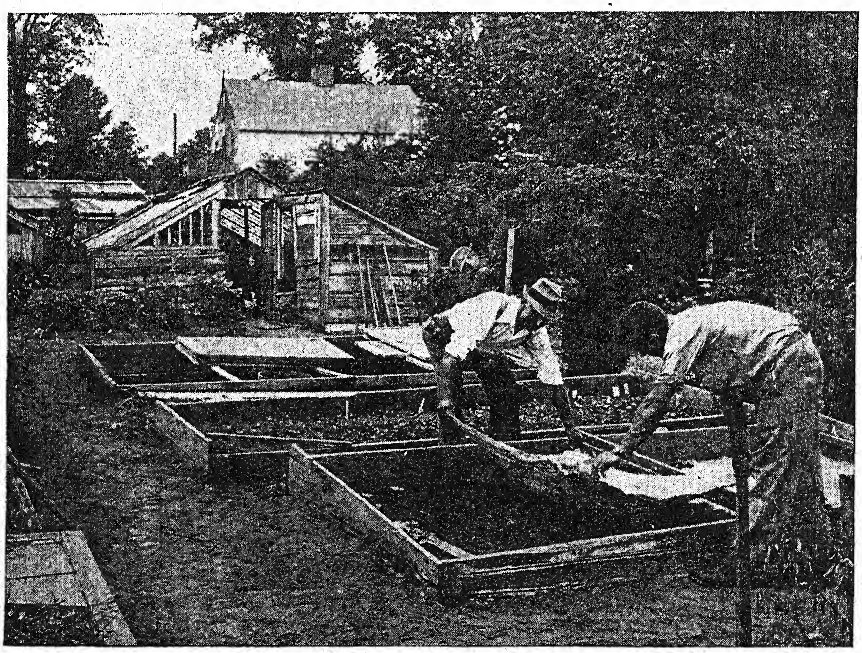
a better utilization of the sun's heat. The frames are usually made 6 feet wide and as long as desirable. However, as the sashes are usually 3 feet wide the length of the frame should be some multiple of 3. A serviceable bed for farm purposes is 6 feet wide and 12 feet long. In cold weather shutters are put on at night over the glass, or some form of mat to better protect the plants.

Fresh horse manure or sometimes sheep manure, is the material generally employed in heating the hotbed. The manure may be spread on top of the ground and the frame set over it, or a pit may be dug in the frame and the manure placed in the pit. On well drained ground the latter is perhaps the more usual way. The fresh manure is first gathered in a pile under shelter. It soon begins to ferment and heat; or if it should be slow about heating, fermentation may be started by pouring a pail or so of hot water on the center of the heap. After the manure begins to heat well it should be forked over and the outer portion of the heap thrown on the inside of the pile. The clear horse manure heats too violently and should therefore be mixed with about its own bulk of leaves or fine straw. When it has heated up the second time it is ready to put in the hotbed.

In the more Northern States when the bed is started, from late February to the middle of March, a layer of manure 18 to 24 or even 30 inches deep should be put into the frame and well trampled down. Farther south, and when the weather is warmer, a layer 8 to 10 inches thick may be sufficient. The manure should extend beyond the dimensions of the frame to more thoroughly keep out the cold, and the outside of the frame should be banked up level with the manure on all sides. As a further protection from cold the hotbed should be made on a southerly exposure protected from the north by buildings, windbreaks or a high, tight board fence.

The manure in the hotbed should be covered 4 to 6 inches deep with good rich sandy soil mixed with compost. There should be a space of 6 to 10 inches between the earth and the sash on the lower side. The manure in the hotbed will heat violently for a few days. When the temperature of the soil begins to fall below 90 degrees F., as indicated by a thermometer, seed may be sown. The manure will continue to furnish heat for 6 or 7 weeks before it becomes exhausted.

Considerable attention is necessary in the care of the hotbed that the plants do not grow spindling and soft. On warm



FARM VEGETABLE HOT BEDS

days the sash at the upper end should be raised 1 or 2 inches, and if the wind is not blowing and the sun shines even more air should be given. As warmer weather approaches more and more air should be given the plants, until the sashes are finally removed entirely during the daytime and left off at night when danger from frost is past.

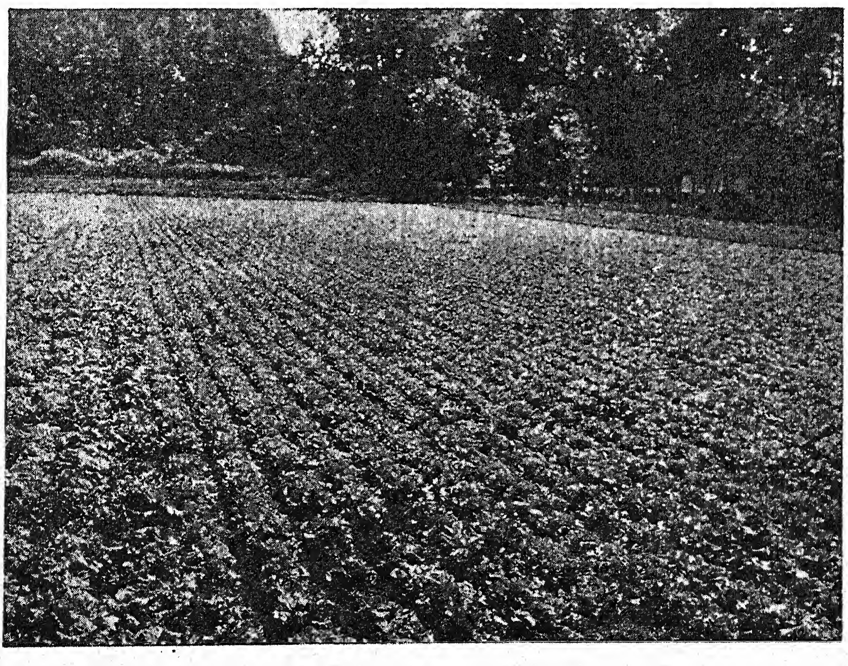
Cold Frame. A cold frame is made exactly like a hotbed, except that no manure is used for heating. The only heat used is that obtained from the sun, which is retained by the glass. Plants can be started in a cold frame sooner than they can be seeded outdoors, but not so early as in a hotbed.

LETTUCE

The commercial lettuce crop has varied from 145 to 175 thousand acres during the past decade, California and Arizona being the leaders in the early crop, and California, Colorado, Idaho and New York in the late crop. Since California raises more than half of the total commercial lettuce of the U.S. that State is able to flood the market east of the Rockies so that growers in these States have been unable to compete except during periods of light receipts from the West, notwithstanding the fact that the transportation cost from the Imperial Valley was $1.70 a crate.

Lettuce is a salad plant of first rank. It is extensively forced in greenhouses during the winter and in hotbeds and cold frames in early spring. Out of doors it is planted from spring until fall. It will withstand quite a severe frost without injury. In farm practice the seed may be sprouted in boxes, kept in the kitchen window, or in a small hotbed or cold frame like cabbage, and then transplanted to the garden as soon as the ground can be worked. It grows best in clay loam soil made rich with well-rotted barnyard manure. The plants should be set 12 inches apart each way. Frequently it is grown between the rows of other plants, like cabbage or cauliflower, and matures and is removed long before these need the space.

Ordinarily in farm practice the seed is sown in the open ground at intervals from early spring to October in rows about a foot apart and thinned to stand 6 or 8 inches apart in the row. The loose growing varieties mature the quickest and should be used for the very early and very late crops. The larger head lettuces are the finest for the early summer and fall crops. The crop should be grown rapidly if crisp, tender lettuce is



FIELD OF ICEBERG LETTUCE

to be secured. To this end the soil should be very rich. A quick growth is sometimes secured by the application of nitrate of soda scattered broadcast along the rows at the rate of 200 to 300 pounds per acre and well raked in. Early Curled Simson or Prize Head is a very good variety for early spring use. Hanson is a solid headed form suitable for spring or early summer. Salamander is another good summer sort, and there are many others. In growing lettuce much depends on the manner in which the seed is grown.

Of late years lettuce has become one of the most important vegetables grown in the greenhouse. It is started in flats in the fall and ultimately transplanted to benches or pots in the greenhouse. If grown in pots 2 or 3-inch sizes are used. The pots are plunged in a bench so that the tops are covered about half an inch with soil. In pot culture, compact early maturing heads are secured which may be marketed without disturbing the roots. The plants thus keep fresh for a long time when exposed for sale. In winter culture the sun is low and the days are short and often cloudy, and the time required to mature a crop is thus often prolonged 2 to 4 weeks. Experiments at the New York Cornell and other stations indicate that the crop may be hastened 10 days to 2 weeks by the use of ordinary electric arc lights or incandescent gaslights. By the use of the latter at the West Virginia Station the lettuce grown was taller, heavier, grew faster and matured quicker than lettuce grown under normal conditions. Ordinarily a crop of lettuce matures in the greenhouse within 6 or 7 weeks from the last transplanting.

Enemies: DROP. *See Stem Rot* under *Cucumber*.

LEAF ROT appears first in the lower leaves which lie on the ground. The green blade rapidly rots away, leaving the midrib unaffected. In plants attacked by drop or leaf mold the midrib is affected first.

DOWNY MILDEW (*Bremia lactucae*) appears as large yellow or dead spots on the upper side of the leaves, with corresponding mildewed areas on the lower side. The disease spreads most rapidly under moist conditions.

ANTHRACNOSE (*Marsonia perforans*) attacks the leaves in small areas which die and fall out, leaving holes in the leaf blade. Small leaves become much distorted and drawn together.

Lettuce is also subject to the attacks of bacterial stem rot, leaf mold, leaf spot and nematodes.

Drop and leaf rot may be entirely checked by sterilizing the soil or by covering the soil to a depth of 2 to 4 inches with sterilized sand. All lettuce diseases are most prevalent in, or almost confined to, greenhouses. Badly infected soil may be removed and the house refilled or the soil may be treated with hot water. Subirrigation lessens the amount of rot by reducing the surface moisture. Fumigation by hydrocyanic acid gas has a slightly beneficial effect in controling lettuce diseases. It should be remembered that lettuce grows vigorously at rather low temperature, while rot thrives best at higher temperature.

CUTWORMS are sometimes destructive to the seedlings. They are best combated by the use of poisoned bran bait.

PLANT LICE may attack lettuce in such numbers as to do serious damage. Nicotine dust containing 2 per cent of nicotine will hold them in check.

MOLES

Moles are small, familiar animals, readily distinguished by their soft dark fur, long pointed nose and large, strongly developed front feet, which are used in throwing aside the dirt in making their burrows. The relationship of moles to agriculture has often been misunderstood, and it is probable that much, if not all, of the injury which is attributed to moles in gnawing the roots of fruit trees and garden crops is really due to mice. Moles, and their nearest relatives, the shrews, are almost exclusively insectivorous in feeding habits and burrow through the ground in pursuit of insects. They are usually to be considered beneficial on account of these habits, but when they burrow extensively in lawns or about the roots of some garden plants they may cause considerable damage. If it is desirable to exterminate them they may be captured in their burrows in the evening by a shovel and spade, or by the use of traps, and carbon bisulphid applied in a manner similar to that recommended for ground squirrels is also very effective.

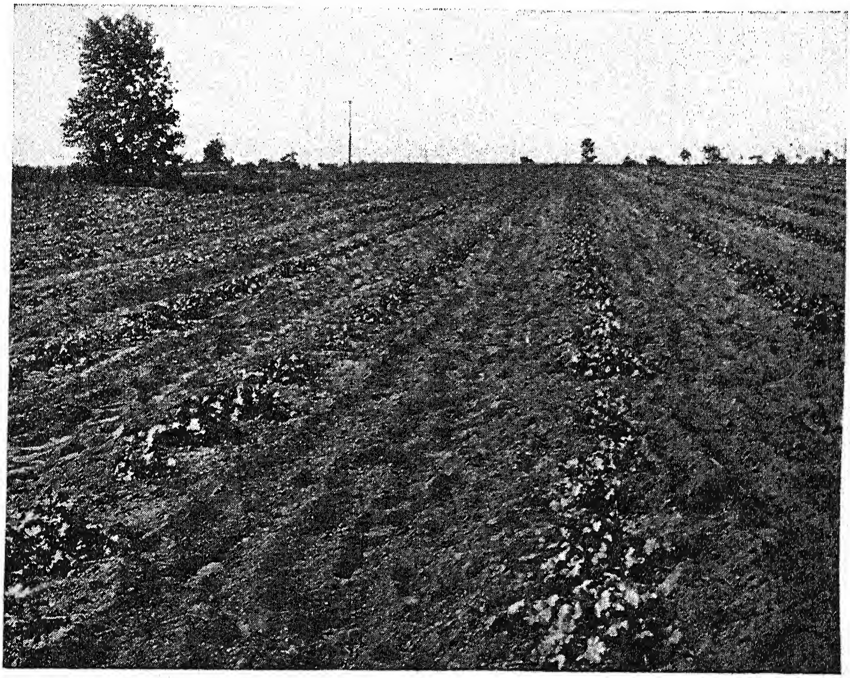
MUSHROOMS

For a long time the demand for mushrooms, fresh, canned or in soups, has been increasing. Commercial growers produce about 35 million pounds annually. The industry is mostly located in certain centers around large cities.

They are frequently called toadstools.

Many edible and poisonous species are common in woods and meadows, but the one usually gathered and eaten or sold in the market is *Agaricus campestris*. This is common in old meadows in the fall and is characterized by having pink colored gills. It varies in height from 1 to 3 inches and in diameter from 2 to 4 inches. Many misleading statements have been made regarding the food value of mushrooms, the term "vegetable beefsteak," etc., being applied to them. Many analyses and digestion experiments show that 75 to 92 per cent of mushroom is water, and the total amount of protein is comparatively small. Not more than half of the dry matter present is digestible. Mushrooms are inferior in food value to potatoes, and this statement about summarizes their food value except from the standpoint of a relish and variety.

Mushrooms are extensively cultivated in the vicinity of cities and bring good prices. The mushroom plant itself is a white or bluish-white mold that grows just beneath the surface of the soil. The part above ground that is seen and eaten may be called the fruit of the plant. This mold or fungus forms a network of threads underground. When grown in specially prepared soil and dried in cakes or flakes it becomes known as spawn and is used for starting new mushroom beds. The details of mushroom growing and the characteristics of the many native edible and poisonous species are too extensive for treatment here.



FIELD OF CANTALOUPS

MUSKMELON

Muskmelon is here understood to include the common forms of muskmelon (called also cantaloup by the trade), honey ball, honey dew, casaba, and Persian melon. The commercial area of these melons runs from 125,000 to 130,000 acres with a production of 13 to 14 million crates yearly, the leading States being California, Arizona, Georgia, Indiana, Maryland, North Carolina, Texas, Colorado and Michigan. Of the total carlot shipments about 13,500 are of the cantaloup type, while 7000 are of other types of melons.

The muskmelon is an annual trailing vine, sensitive to frost, bearing round or oval fruits which weigh about 1½ to 6 pounds. It is successfully grown all over the United States and is an important commercial product. It resembles the cucumber in manner of growth and is cul-

tivated like it. Contrary to the usual belief, it does not cross with cucumbers, squashes, etc., and the quality of the fruit is not injured when they are planted with or near these crops. The term cantaloup is frequently but incorrectly applied to the whole group of muskmelons. It is properly applied to only one group, *Cucumis melo cantalupensis,* which is characterized by a hard, scaly and often deeply furrowed rind, having a warty appearance like a Hubbard squash. The out somewhat, a little rich dirt filled in, and 6 to 8 seeds planted on each. Bottomless berry boxes or tin cans filled with rich soil may be used in the same way. The plants should be hardened off and set in the field after all danger is past, and the 3 strongest plants allowed to stand in each hill. A cloudy day or late afternoon is the best time for transplanting. In dry weather a pint or more of water should be given each hill after the plants are set.

GATHERING CANTALOUPS

true cantaloup is little grown in this country.

Soil and Planting. The muskmelon requires a quick, warm sandy loam for its best growth. It is a long season crop, and in the North, especially, the plants are frequently started under glass. Experiments at a number of stations show but little, if any, advantage for this practice over outdoor planting. In Arkansas, however, it increased the earliness of the crop from 12 to 20 days. In farm practice transplanting is not advisable, but the special grower may find it profitable. Muskmelons transplant with difficulty. It is generally advised that they be planted on thick sods cut 4 inches square. These should be placed close together, grassy side down, in a hotbed hollowed

Fertilizing. The usual practice in growing melons outdoors is to plant 10 to 15 seeds in hills 3 feet apart in rows 6 feet apart. In growing on a small scale a couple shovelfuls of well-rotted barnyard manure should be spaded deep under each hill. Three or 4 inches of soil should be put over the manure, the seed planted and covered with 2 or 3 inches more of soil, making the top of the hill slightly above the level of the ground.

At the Arkansas Station Walker found that applying the manure to the surface of the ground and working it into the soil with a fork gave just as good or better results as regards yield, size and earliness of melons as by digging a hole and putting it under the hill or in trenches around the hill, and much cheaper. In com-

mercial practice he recommeds that the manure be applied in strips 8 to 10 feet apart on well-prepared land. The manure should be mixed with the soil by passing back and forth several times along the strip with a bull tongue or single shovel plow, after which the soil should be thrown into a low, broad ridge, dragged and harrowed. On this strip the seed should be planted about 18 inches apart.

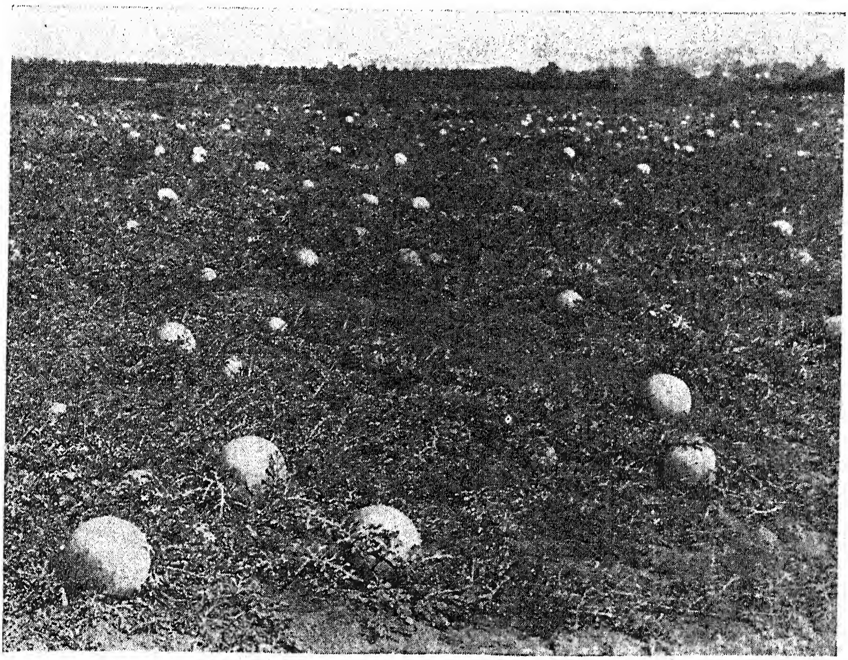
The New Jersey Station secured an increase in yield of muskmelons of 115 per cent by the use of 150 to 200 pounds of nitrate of soda per acre. Half the fertilizer was applied at planting time about the hills and worked into the soil, and the remainder about 3 weeks later. Dried blood and sulphate of ammonia used in the same manner were a little less effective, but increased the yield from 87 to 91 per cent. A handful or two of fertilizer should be mixed into the soil of each hill.

In the West, where irrigation is practiced the water should be kept confined to the furrow and reach the roots of the plants only by percolation. This keeps the melons dry and the vines from becoming covered with sand.

Among the numerous varieties of melons mention should be made of Defender, Hearts of Gold, Powdery Mildew Resistant No. 45, Rocky Ford, Tiptop, Golden Beauty Casaba, Honey Dew, and Santa Claus Persian.

Melons occupy considerable space, rather too much space for a small home garden where their cultivation can hardly be justified.

The diseases and insect pests which cause trouble in melon growing are the same as those which attack cucumbers and are considered under that crop.



MELONS IN OREGON

MUSTARD (*Brassica* spp.)

Mustard is grown for "greens" and for seed, the latter forming the well-known condiment. The best of the mustards for greens is *B. alba* which is to be sown thickly in drills in spring or fall. The Black Mustard (*B. nigra*) is the one chiefly grown for seed. Mustard requires a warm, rich soil, preferably of a sandy loam nature. It is seeded either broadcast or in drills; if broadcast about 8 quarts of seed per acre are required; if in drills 24 inches apart 6 quarts is sufficient. Plants are left 6 to 12 inches apart in the row. When a majority of the pods have turned yellow the crop is cut with a reaper or scythe and put in piles for a day or so to cure. It is then drawn

to the barn and, when perfectly dry, threshed.

Mustard frequently becomes a weed, but is easily controlled by cultivation.

GUMBO or OKRA (*Hibiscus esculentus*)

Okra or gumbo is a tender annual vegetable of easy culture. It is grown mostly in the South. The part eaten is the green mucilaginous pods which are used in soups, sauces and stews. It thrives in all garden soils. The seed is sown about the time snap beans are put in. It should be seeded 1 inch deep in drills 2 to 3 feet apart, depending on the size of the variety grown, and the plants thinned to stand 12 to 18 inches apart in the row. The green pods are used for cooking as long as they snap readily. Older pods should be removed so that the plant will remain longer in bearing. The green pods may also be preserved in brine like cucumbers or dried for winter use.

Dwarf varieties are best for the Northern States. Of these Dwarf Green, and White Velvet are among the best.

ONIONS

Onions is here used in the plural to include a group of closely related plants known as Chives, Garlic, Leek, Onion and Shallot. Most if not all of them have been used for human food since the earliest historical times. In the Book of Numbers we read the complaint of the hungry Israelites, "We remember the leeks that we did eat in Egypt and the onions and the garlic." In 450 B.C. Herodotus learned that the expenditures for onions in the rations of the thousands of workers during their 20 years of toil in erecting the Cheops pyramid amounted to the equivalent of $2,000,000, a convincing proof of the important role played by onions in human affairs. Leaving out of consideration for the moment the small family patches in farm gardens (and it would be difficult to find such a garden without onions in it) the commercial onion production in the U.S. has been 14 to 17 million sacks during the past few years, raised on about 120,000 acres, chiefly in New York, Michigan, Colorado, Texas, Idaho, Oregon, California, Wisconsin, Indiana, Massachusetts and New Jersey. The early crop comes mostly from Texas, Arizona and California.

Probably no garden crop is more nearly universally distributed than onion. One can scarcely find, even off the beaten track, on any of the continental areas or in the islands of the seven seas, a locality where one or another of the onion group is not raised for food. To this ubiquity there is joined a corresponding adaptability to the most varied soil and climatic conditions. This is particularly true for onions. In this country chives, garlic, leek and shallot are grown chiefly in localized areas in trucking centers near large cities. Onion production has kept pace with the onion consuming capacity of our population, and, as is the case also with potatoes, the price of onions rises and falls according as the crop exceeds or comes short of the average level of production.

But while the onion is remarkably adaptable to soil and climate, there are certain conditions which are essential to the best returns. The onion needs an abundant and uniform supply of moisture during its active growing life, but must have dry weather for the final stages of ripening. Unless the bulbs can be thoroughly dried and cured before harvesting, the quality is inferior and heavy losses from decay may be expected. Arid regions with adequate irrigation water for the growing season can most easily provide those conditions. Even our northern humid sections are usually favored with a dry period in fall when the onions may be properly cured.

Onions cannot ordinarily be planted year in and year out on the same land without running into trouble. The ground becomes so thoroughly infested with disease and insect pests that satisfactory returns from onions are impossible. In every locality a short rotation may be devised to avoid that difficulty, but the intervening crop should not be one that takes too much fertility from the soil. A legume to be plowed under as green manure is first choice.

The best soil for onions is a rich, well-drained loam. Heavy clays, hillsides and stony land should be avoided. Excellent crops are grown on deep, rich muck lands that have been under cultivation for 3 or 4 years. Such lands should contain a fair admixture of sand and the water level be about 2½ feet below the soil surface. New, raw muck lands give poor returns. The land for onions should have been into some heavily manured hoed crop the preceeding season and practically free from weed seeds. It is a mistake to attempt to grow onions on weedy or run-down land.

A rather firm seedbed which results from fall plowing is desirable and gives the best results. A second crop of clover

heavily fertilized with barnyard manure and turned under in the fall, followed by potatoes the next spring, makes an excellent preparation for onions the second year. A heavy top dressing of well-rotted barnyard manure or compost should be applied in the spring at the rate of 40 to 50 2-horse wagon loads and well worked into the soil with a disk harrow or narrow bladed cultivator; after this a complete commercial fertilizer analyzing 4 per cent nitrogen, 8 per cent available phosphoric acid and 10 per cent potash should be applied. This is the fertilizer formula so popular with Long Island onion growers and should be applied broadcast at the rate of 500 or 1500 pounds per acre. If the land has been in a high state of cultivation for some years the commercial fertilizer may replace in part the barnyard manure. Onion soil, however, cannot be made too rich. A top dressing of ashes and hen manure might also replace in part the commercial fertilizer. The most successful growers use them all, and in addition, from 250 to 750 pounds of nitrate of soda applied broadcast in 3 or 4 applications during the growing season.

Seeding. After the top dressing of fertilizers, hen manure, ashes, etc., has been applied it should be lightly harrowed in and the ground leveled with a smoothing harrow preparatory to seeding. The onion is one of the hardiest of our vegetables, and the seed should be in the ground as early in the spring as the land can be worked. In the North the seeding should be completed by the middle of May. Farther south seed is sown from February to April, and in Texas and some other localities fall seeding is practiced. The rows should be 12 to 14 inches apart in hand cultivation, and about 30 inches in horse cultivation. Hand cultivation is usually practiced, and at the Texas Station was found to be as cheap and much more profitable than horse cultivation.

From 18 to 30 seed, depending on their vitality and the danger from grubs, are sown per foot of drill and covered 1 inch deep. Care should be taken that the seed drill drops correctly. Buy only the best seed. From 3 to 6 pounds are required per acre.

For small scale operations or home garden purposes, there may be an advantage to be gained by sowing the seed early in the seedbeds and then transplanting the seedlings, or by growing onion sets to be planted the next spring in the field. But

ONION SEED CROP IN NEVADA

in extensive plantings sowing directly in the field, in rows 24 to 36 inches apart for horse cultivation or closer for hand culture, by means of seed drills is the prevailing method. Horse drawn drills are in use that plant as many as 7 rows at once. For such operations the soil must be put in the best possible tilth, level, finely pulverized and firmly packed. The system of seedbed and seedling transplanting is used in growing Bermuda and Creole onions in order to get an earlier crop of more uniform size.

With all types of onions frequent shallow cultivation is imperative. Onions cannot endure weediness. Wheel hoes for hand work, preferably with a single wheel, are quite adequate for the purpose, 10 or more weedings usually being required per season depending on weeds and weather.

Harvesting. As the onion bulbs approach maturity the stalks become weak just above the bulbs and fall over on the ground. When the bulk of the tops have died down the crop is ready for pulling, even if some tops are still green and standing. Throw 2 or more rows together and leave on the ground for a week or more to cure. The tops of the onions may be twisted or cut off at any time before marketing, but preferably when they are stored.

Storing Onions. If the onion crop is kept till spring it should be stored in a dry cool place. In a damp cellar they are almost certain to sprout, even if the temperature is nearly down to freezing. A dry loft is the best place for them. Freezing does not harm them, but repeated freezing and thawing makes them soft and induces sprouting. If they are frozen at the beginning of the winter they should be kept so until spring. After they thaw out they do not keep well and should be disposed of as soon as possible. Onions should never be put in deep piles, but spread out in shallow layers not more than 12 to 18 inches deep. They keep well in barrels with the heads out and holes bored in the sides to admit of a good circulation of air, or in slatted bins.

Early Onions. The early green onions of spring are usually grown from sets or bulblets. Onion sets are grown by drilling in 30 to 40 pounds of seed per acre. Soil of only medium fertility is used and the seeding delayed in the spring until after most of the weeds have started. The object of thick seeding is to secure a crop of very small bulbs from the size of a pea to half an inch in diameter. They should be harvested in August or September and treated like the main crop of field onions. When these small onions (sets) are planted out 2 to 3 inches apart in rows a foot apart and about 3 inches deep they form a new bulb, which is ready for bunching and the table by early summer. Good, well enriched soil should be used and the plants kept cultivated, throwing the soil toward the plants. In the South sets and multipliers or potato onions may be put out in the fall. The use of sets practically insures a crop. It requires from 6 to 10 bushels to set out an acre.

Among the numerous varieties of onions from which choice may be made for use in home gardens, the Multiplier is a favorite for early green onions, and White Globe, American Silverskin, Yellow Danvers and Red Globe for main crop.

Chives. This is a slender perennial plant resembling green onions, usually growing in tufts, and used as flavoring for soups and meat stews. Planting requirements are the same as for onions if planted in rows, or they may be treated as a border row to the garden. As a border chives require little attention. They persist for several years and may become so matted that they require separation and transplanting.

Garlic, a plant closely related to the onion, to be planted at the same time and to be given the same treatment in fertilizers and cultivation, is used chiefly as a seasoning. It is propagated by sets known as "cloves". Each bulb is made up of several smaller segments which are separated for planting, in good soil 4 to 6 inches apart. The bulbs mature in the fall and are then pulled, cured and tied in bunches, or more frequently braided into strings in which form they appear on the market. Garlic is in greater favor in Europe and Latin America than in the U.S. and must be rated as of minor importance in our home gardens.

Leek is a flat leaved perennial of the onion family, somewhat milder than the onion, used chiefly for seasoning in cookery. The stem is like a large green onion without a bulb, attaining a length of 6 to 8 inches and an inch or more in diameter. The leek is started from seed and otherwise handled in the garden like onions except that they are often planted in trenches and then hilled up as growth proceeds.

Shallot is a perennial small type of onion, of a mild, delicate flavor, propagated by the cloves or segments into which the bulb splits. The bulbs are used

like onions, and the leaves like chives which they resemble but are wider. It is said to have been introduced into Europe from Asia and came to the U.S. from Europe.

Enemies of Onions: SMUT is perhaps the worst disease of this group of plants. It is due to a soil fungus which develops into masses of black powder in the leaves. Infested soil should be avoided if possible, if not "sprinkle formaldehyde solution (1 teaspoonful to a quart of water) in the drill after dropping the seeds, using about 3 quarts to each 100 feet of row."

The ONION THRIPS, a small insect which sucks the sap from the leaves causing an injury often called blast, may be conquered by repeated spraying with nicotine sulphate.

The ONION MAGGOT may cause havoc in the crop by eating into the bulb and inducing decay. Tarred paper placed about the base of the stems may prevent the flies from laying their eggs, or dissolve ½ ounce corrosive sublimate in 5 gallons of water, pouring a half teacupful into the soil at the base of each plant.

PARSLEY (*Carum petroselinum*)

The leaves of this plant are used for garnishing meat, fish and other dishes, and as a flavoring for soups and stews. The plant is a low-growing perennial usually cut-leaved. It grows in any good garden soil. The seeds are very slow to germinate. They should be sown early in the season in rows 10 to 12 inches apart and the plants thinned to stand 3 to 4 inches in the row. A few plants will supply a family. If protected the plants will live over winter, or the roots may be put in boxes or pots and kept in the house, where they will furnish a winter supply of leaves.

Turnip rooted parsley is sometimes cultivated. The roots are boiled and used like celeriac.

PARSNIPS (*Pastinaca sativa*)

This is a hardy vegetable used for both human food and for stock. It is grown like carrots are. The soil should be deep, mellow and rich and of a loamy nature. The seed must be fresh, not over a year old. Sow ½ to 1 inch deep in rows 15 to 18 inches apart. The seeds are slow to germinate and it is sometimes necessary to break the crust that may form in the soil over them before the plants will push through. Thin the plants to stand 3 to 4 inches apart in the row. Cultivate and keep the weeds out until the tops shade the ground. The crop may stay in the ground over winter and is improved in quality by freezing. If thus managed, however, the roots are frozen in during the winter and cannot be marketed if favorable opportunity offers. It is customary to dig them late in the fall and store in pits or in a cool cellar.

Hollow Crown and Guernsey are good varieties. Half Long is well suited to medium deep soils, and Long Smooth to rich, deep soils. Stock readily eat the surplus or unmarketable crop.

For enemies *see* under *Celery*.

PEAS

Few home gardens are without a small area at least of peas for the table. Peas may be picked in the right stage for eating in the west coast of Mexico, or in the Gulf States, or California, packed in crates with cracked ice or otherwise, and arrive in Atlantic coast cities in good condition. But peas served steaming hot on the dinner table within 30 minutes of picking in the home garden are so far superior in flavor to peas which have been shipped from a distant, or even near by, trucking region, that their tenderness and palatability richly repay the small trouble of growing them in your own garden.

Of the smooth seeded varieties Alaska is most used for planting in early spring. Hundred Fold and Little Marvel are good early varieties of the wrinkled sort. For a late variety requiring a trellis or support Telephone is hard to beat.

Peas are a cool weather crop. In the Northern States the first planting may be made as soon as the soil can be put in good tilth, to be followed by a succession of plantings at 10 day intervals.

Garden peas require a good, well-worked garden soil. Well-rotted barnyard manure and ashes are the most suitable fertilizers, but if the ground has been well fertilized with barnyard manure the preceding season, no more need be added. Plant as early in spring as the ground can be worked, the early dwarf forms in rows about 8 to 10 inches apart, leaving a wide row for gathering about every fourth row, and the late tall-growing varieties in rows 6 to 8 inches apart, leaving about 3 to 3½ feet between each 2 rows. About 1 quart of seed is needed to plant 100 feet of row. The dwarf forms do not need trellising but the later sorts will need support. Brush stuck in between the 2 closely planted rows makes

one of the best supports. But little attention beyond shallow cultivation and brushing is required. By planting at intervals, and by using early, medium or late varieties, a succession of peas through-the season may be obtained.

Diseases and insect enemies of garden peas are treated under peas in field crops.

PEPPERS

Peppers are grown commercially on about 23,000 acres with a total production of 5 million bushels chiefly in New Jersey, North Carolina, Florida, California and Texas for marketing in addition to the pimiento type grown for canning. The garden pepper is native to North America and is quite unrelated to the black and white peppers of commerce.

The pepper is a vegetable grown for seasoning pickles, meat sauces, relish, etc., often referred to as red peppers, but the fruits are white, yellow, green and violet colored as well as red. The young plants are raised like tomato or eggplants. Frost injures them while they are young, but in the fall they withstand quite severe freezes. Set the plants about 2 feet apart in rows 3 feet apart. Of the varieties grown Long Red Cayenne is one of the most pungent. Chili and Cranberry are other good varieties of this sort. For making stuffed pickles Sweet Mountain, Ruby King, and Large Bell or Bull Nose are excellent varieties.

Enemies: ANTHRACNOSE appears as soft spots, which crack open on the surface of the fruit. In another form of the disease the spots turn black. Fungicides are of little avail in the treatment of this trouble. Irrigation and mulching are beneficial.

BOLL WORM. *See* under *Cotton.*

ARMY WORM. *See* under *Wheat.*

POKE (*Phytolacca americana*)

This is commonly called pokeweed or inkberry or garget, grows wild along fence rows and out-of-the-way places in rich soil. The shoots in early spring are cut and eaten as greens like asparagus. In some cities the young shoots appear on the markets in considerable quantities. Poke may be cultivated like asparagus by splitting the crowns into pieces for setting in the garden. The root is poisonous but has been used as medicine. In summer the black berries yield a purple ink-like fluid.

PUMPKIN (*Cucurbita pepo*)

The pumpkin was formerly extensively cultivated for culinary purposes but has been supplanted in a large measure for this purpose by improved varieties of squashes. Its chief use now is as a stock food. It is a rank-growing trailing plant easily injured by frost. Like melons and squashes, it thrives best on warm, sandy loam. In the Northern and Central States pumpkins are quite generally grown in corn fields, a seed being placed in every third or fourth hill of every third or fourth row. Where the vines grow so rapidly as to interfere with the culture of the corn, as in some parts of the West, the seed should be planted in hills 8 to 12 feet apart each way. In such cases 6 to 8 seeds should be put in each hill, and 3 of the strongest plants allowed to grow. A field of well prepared land given up exclusively to this crop pays well when rightly managed as a fall feed for cattle and pigs. Pumpkins should be broken up when fed to cattle. They may be fed either raw or cooked with meal for pigs. For dairy cows pumpkins were found equal to silage by the Vermont Station. They were cut up and fed seed and all. No harm resulted from feeding the seed.

Of the various varieties of pumpkins Connecticut Field is one of the most prolific. It is a large, round early sort excellent for stock. The Sugar pumpkin is especially valuable for pies. Canada and Cheese pumpkins and Acorn, are other good varieties.

RADISH (*Raphanus sativus*)

The radish is primarily a hardy, quick-growing, early-season garden crop. It requires rather cool weather for its best development, and growth must be continuous from start to finish to secure tender radishes. The crop is well suited to hotbed culture in early spring, and is also a popular greenhouse crop. For family use sow large, heavy seed in clean, rich garden soil as early in the spring as the ground can be worked, and every 10 days thereafter as long as desired. The roots will be large enough for the table in 4 to 6 weeks from the time of planting. Sow in rows 6 to 12 inches apart and cover ½ inch deep. Drop 2 or 3 seeds to each inch of row. One ounce of seed is sufficient for 100 feet of row, or from 8 to 10 pounds per acre.

Radishes are likely to be stringy and tough when grown in hot summer weather. Winter radishes are grown like turnips are and should be planted the latter part of July or first of August. These winter radishes are firm and keep well over winter stored in the cellar or in pits. They

are not as much grown as their merits deserve.

There are many varieties of radishes, differing from each other in form, size, color and taste. French Breakfast is one of the best early varieties and the most popular market sort. Another good early variety is Scarlet Turnip. Black Spanish, White Spanish, and Scarlet Chinese are good winter kinds.

For enemies *see* under *Cabbage*.

RHUBARB (*Rheum rhaponticum*)

Rhubarb is also called pie plant. This is hardy everywhere and one of the first sauce and pie plants in the spring. It is generally propagated by division of the fleshy crowns. Pieces of crowns are set in mellow soil in rows 5 feet apart and about 3 feet apart in the row. The root pieces should be set with the crowns about 4 inches below the surface of the soil. The ground should be kept well cultivated the first season and stalks may be pulled the following spring.

The soil for rhubarb should be made extremely rich by the addition of an abundance of barnyard manure every other season. A good surface dressing of manure should be applied. The third or fourth year after planting the hills should be divided by cutting through them with a sharp spade and removing all the roots but 3 or 4 buds. If this is not done the buds become so numerous that only small, weak stalks are produced.

Rhubarb is also grown from seed, but varieties true to name can only be grown from crowns. In growing from seed good, clean garden soil should be used and the seedlings started in beds in early spring in rows 12 inches apart and 1 inch deep. Thin the plants to stand 6 inches apart and cultivate throughout the summer. The following fall or spring they should be set out in the field in the same manner as noted for crowns above. The second season stalks may be pulled freely. Eight to 12 plants will supply a big family.

Forcing in the Cellar. Rhubarb can be easily forced in the farmhouse cellar in winter and the stalks had 6 weeks to 2 months earlier than usual. Experiments at the Rhode Island Station show that for this purpose crowns should be dug late in the fall and allowed to freeze. They should then be removed to a frost proof cellar and buried 3 or 4 inches deep in moist sand. Light is not essential to their growth. In fact, in the station experiments the plants grew better in darkness than in light. It is very essential that the plants should be frozen. If the room occupied by the roots is small a lighted lantern kept near them will give out heat enough to considerably hasten their growth. Rhubarb is also forced to a considerable extent for market in special houses, cold frames, under the benches in greenhouses etc. Victory and Mammoth Red are good varieties.

Enemies: RHUBARB CURCULIO (*Lixus concavus*) is a rust colored snout beetle about ¾ inch long, which bores into rhubarb stalks, causing a fluid to exude. The beetles may be readily recognized and collected by hand, or all wild dock growing in the neighborhood of the rhubarb patch may be destroyed in July after the beetles have laid their eggs on them.

RUTABAGA (*Brassica campestris*)

Known also as Swedish turnip. A hardy biennial plant similar in nature to the turnip. The root is a large fleshy bulb and is produced the first year. The seed matures the second year. Rutabagas are used largely for stock food, and to some extent as a table vegetable. This is the turnip so much grown in England and Northern Europe for sheep.

The rutabaga does best in rich, well-prepared loam soils. When grown for stock it should be sown from the middle of June in the Northern States to the middle of July. The seed should be drilled in rows 18 to 24 inches apart and the plants thinned to stand 6 to 10 inches in the row. From 2 to 2½ pounds of seed is required to seed an acre. The crop should be given thorough, shallow cultivation. It makes its best growth in the cool months of autumn and is not injured by frosts.

The crop should be harvested just before the ground freezes and stored either in pits, cellars or root houses. Rutabagas are easy to grow and the roots keep better than potatoes. Yields of from 10 to 15 tons per acre are common. One of the best varieties is Purple Top. Rutabagas are about equal in feeding value to corn silage; but it costs more to grow them. (*See* under *Sheep*.) Rutabagas may be sown early in the spring and an early summer crop secured for the table if desired.

SALSIFY (*Tragopogon porrifolius*)

A hardy biennial vegetable, also called vegetable oyster. The tap root is long and fleshy, resembling that of the parsnip. The leaves have a grass-like appearance. The plant is not grown for stock. Salsify

requires a deep, rich, cool soil and the whole season to mature in. Plant the seed 1 inch deep in drills about 12 inches apart and thin the young plants to 4 or 5 inches apart. Eight to 10 pounds of seed is required per acre, or 1 ounce to 70 feet of drill. Keep free from weeds throughout the season. The roots may be dug and stored in late fall or left in the ground over winter. The roots when cooked have the flavor of oysters.

Scorzonera or **Black Salsify** (*Scorzonera Hispanica*) is cultivated like salsify as noted above. The plant, however, is a perennial, and the roots continue to enlarge if left in the ground for more than one season without becoming inedible. The root of this plant is black. It is used in the same way as salsify.

Scolymus or **Spanish Salsify** (*Scolymus Hispanicus*) is grown like salsify and used for the same purpose and in the same way. It yields considerably heavier than salsify and the oyster taste is not so pronounced.

Enemies: Bacterial Rot sometimes causes a complete decay of the roots and wilting of the leaves. Decayed roots are slimy and foul smelling. Attention to drainage and rotation of crops will check the trouble.

White Rust may appear on the leaves and leaf stem, causing them to curl and become distorted.

SPINACH (*Spinacia oleracea*)

Spinach is the leader in crops grown for greens, about 61,000 acres being raised commercially for the fresh market, and 16,000 acres for canning. Texas, California, Virginia, Pennsylvania and Louisiana are the chief producing States. It is a regular stand-by in home gardens in almost every State.

It is very hardy and most in demand in very early spring and late fall. The seed stalk grows about 2 feet high. The leaves are rather large and succulent. It is of very easy culture and grows best in cool weather. Quick, rapid growth is very desirable with this plant, so that the leaves and stalks may be tender. The soil should therefore be rich in humus and in fine tilth.

Culture. The seed may be sown in a hotbed or cold frame or outdoors just as early in spring as the ground can be worked. When seeded outdoors the rows

CULTIVATING SPINACH

should be about 12 inches apart. Sow about 40 seeds to each foot of row and cover 1 inch deep. When grown for market a top dressing of nitrate of soda at the rate of 150 pounds per acre is quite generally recommended. Apply the nitrate of soda broadcast in 2 applications about 2 weeks apart soon after the plants get nicely started. The leaves will be large enough to gather in about 8 weeks. Plant at intervals of 2 or 3 weeks for a succession throughout summer and fall.

For the very early spring crop the seed should be sown in August or early September. On the approach of winter in the Northern States cover the crop with a couple inches of straw, leaves or other clean litter. This will generally protect the crop over winter. Very early in the spring the cover should be removed. The crop grows rapidly and can soon be gathered for the table. In market gardening it is especially desirable to apply nitrate of soda to the crop in the spring as noted above. The plant grows more rapidly and the yield is about doubled. If nitrate of soda is not available a dressing of hen manure or well-rotted barnyard manure will give good results. When thus grown over winter the spinach field should be made into slightly raised beds 6 to 9 feet wide so that water will not stand on the plants. The rows should run lengthwise of the bed. Fall sown spinach should be ready for use in April and May and the crop off the ground in early June.

Varieties. There are 2 races of spinach, the prickly seeded and the round seeded. The prickly seeded variety are hardiest and most used for fall planting. Long Standing is considered an excellent sort for early spring and summer use. Round Leaved is a good shipping variety. Prickly or Winter is valuable for fall seeding. Bloomsdale is another excellent sort.

New Zealand Spinach (*Tetragonia expansa*) is not a spinach at all. It grows well in summer, however, and is one of the best substitutes for spinach.

Enemies: MILDEW (*Peronospora effusa*) appears as gray, velvety patches on the under side of the leaves, with corresponding yellow spots on the upper side. It occurs also on pigweeds and lamb's quarters.

ANTHRACNOSE (*Colletotrichum spinaceae*) appears as gray spots on the leaves, containing brown pustules. The disease has no preference for the upper or under side of the leaves.

LEAF BLIGHT (*Phyllosticta chenopodii*) forms numerous minute pimples on the lower part of the leaf.

WHITE SMUT (*Entyloma Ellisii*) differs from the grain smuts in that the spores are colorless and give the leaves a frosted appearance.

BLACK MOLD (*Cladosporium macrocarpum*) occurs on old leaves as dark blotches. The disease seldom attacks young, vigorous plants.

In treating any of these diseases rotation of crops and destruction of affected plants is recommended. A mixture containing equal parts of sulphur and air-slaked lime may be raked into the bed before planting.

Spinach is usually free from insect pests, but may be attacked by the leaf maggot (*Pegomyia vicina*). The eggs are deposited on the under side of the leaves and the larva mines in the tissue of the leaf. The mine soon resembles a blister. The insect feeds on spinach, beets and weeds such as lamb's quarters. These weeds should be destroyed in the neighborhood of spinach and beet fields. Deep early spring or late fall plowing, followed by rolling is recommended.

SQUASH (*Cucurbita* spp.)

This term also includes what are sometimes called pumpkins. According to Bailey, what was called summer squashes belong mostly to varieties of *C. pepo,* and the winter squashes to *C. maxima* or *C. moschata,* but chiefly to the former. Squashes are grown as a table vegetable and for making pies.

Squashes, like cucumbers and melons, require a warm, fertile soil of a sandy nature for their best growth. Summer squashes grow mostly in compact bush forms. The hills for these should be about 4 feet apart, and for the long trailing fall and winter varieties 8 to 12 feet each way. The hills should be 12 to 18 inches across, and if the ground is not already rich, 2 or 3 shovels of well-rotted manure should be worked into it. Frost easily kills the plants, and the seed should not be sown outdoors until the ground is warm and the weather settled. Put 8 to 10 seed in each hill and cover 1 inch deep, firming the soil down with the hoe afterward. When danger from bugs is past thin the hills to 3 or 4 of the strongest plants.

The male and female flowers of the squash are separate on the same vine, and in some of the newer prairie sections where insects are not abundant, it may be necessary to hand pollinate the flowers.

PLANTING SQUASH IN POTS TO BE TRANSPLANTED

This is done by dusting the pollen of the male flowers on the stigmas of the female flowers.

Harvesting. Summer squashes are cooked and eaten whole before the skin hardens. Winter squashes may also be eaten in a green state, but are not stored for winter use until the skin has hardened. Winter squashes should be gathered as soon as fall frosts threaten. Leave on about an inch of stem and let the squashes lie in the sun for a few days, covering at night with vines and other litter, to protect them from frosts until the skin is hard and flinty, then store in dry rooms having a temperature of about 50 degrees F. Care must be observed not to bruise the skins or they will not keep well. Store in tiers not more than 2 deep.

Varieties. Summer Crookneck is an excellent summer sort. Bush Scallop is a popular market gardening sort. Of autumn varieties Boston Marrow is one of the best, and the Hubbard the best known and best keeping winter variety.

For fungous diseases *see Cucumber*.

SWEET POTATO

Sweet potato, a member of the Morning Glory family, has become a highly important vegetable crop from New Jersey south to Florida and west to California. Outside of this commercial belt the sweet potato is grown sparingly in home gardens as far north as Maine. It is a native of the American tropics and requires for full maturity a 4-month frost free period. During the past decade sweet potatoes have been grown on ¾ to 1 million acres with a total commercial crop of about 64 million bushels. About 90 per cent of the crop is raised in the Southern States. Yields up to 100 barrels per acre may be expected under good management.

Until recent years, sweet potatoes appeared on the northern markets for only a short season and not in great abundance. They are, unless carefully handled, a highly perishable crop and will not keep long or stand transportation far from the point of production unless properly cured. In recent years special storage houses have been built providing heat and ventilation whereby skin injuries heal quickly so that infection with rot is obviated, and enough of the moisture content is removed to prolong the period during which the sweet potatoes may be safely held. Recent experiments indicate that the benefits secured by this system of curing are not primarily due to a reduction of the moisture content but to

YELLOW CROOK-NECK SQUASH

hastening the healing of skin injuries and thus preventing bacterial infection. The market period is thereby stretched so that sweet potatoes are far more widely distributed in northern markets than formerly.

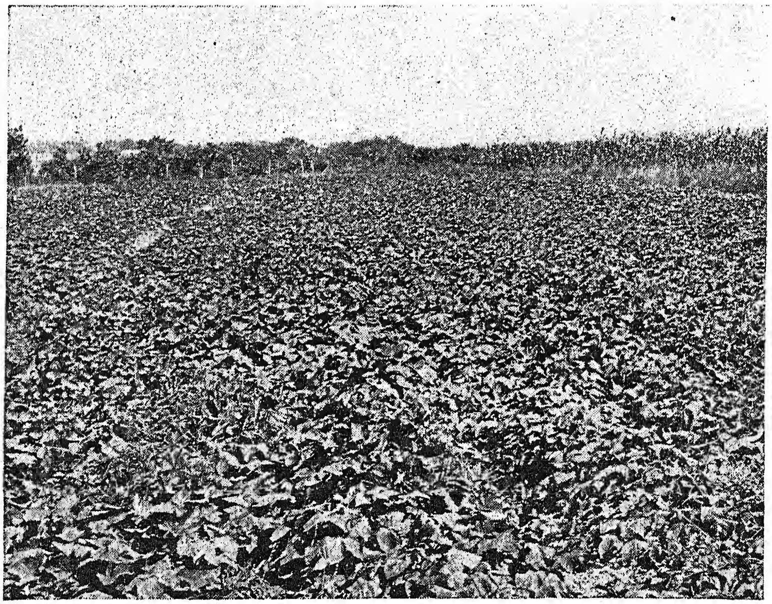
Still more recently an active interest has grown up in the sweet potato as a source of starch. The starch mills are unable to pay as much for sweet potatoes as may be obtained on the city vegetable market, but they can process large quantities of them and thus expand the outlet for excess production. A factory in Laurel, Mississippi, has manufactured as much as 2½ million pounds of starch from sweet potatoes in a season. From 250 bushels of sweet potatoes, a by no means excessive yield, a ton of starch is obtained. The Louisiana Experiment Station asserts that more starch per acre can be produced from sweet potatoes than from any other crop grown commercially in this country. This starch is not only suitable for ordinary uses but also for adhesives and other purposes.

There are two general classes of sweet potatoes, the dry mealy New Jersey type and the Porto Rico type which is of moister flesh. The crop is adaptable to a wide variety of soils. Good drainage is desirable but the land need not be so heavily fertilized as for onions. In fact the crop is likely to run too much to vines on overfertilized soil. In a rational rotation, in which a legume is turned under, medium yields of sweet potatoes may be obtained even on worn out cotton or tobacco land.

Propagation. Sweet potatoes are propagated from sets or shoots which spring from the tubers when they are planted, and from cuttings taken from the tips of the runners. The sets are obtained by planting the potatoes in a hotbed, frame or structure furnishing artificial bottom heat. The layer of manure under the hotbed in the North should be 8 to 12 inches thick. In the South a layer 2 to 5 inches will be sufficient. The temperature of the bed should be from 75 to 80 degrees F. A layer of sand or soil 1 to 3 inches thick is placed over the manure. The tubers are placed in a single layer on the sand close together but not touching, and covered 2 to 3 inches deep with soil. Small tubers appear to be just as good for the production of sets as large or medium sized ones. If large tubers are used they should be cut lengthwise and placed in the bed cut side down.

The roots should be bedded 5 or 6 weeks before the sets are wanted for

planting out. The sets are broken from the potatoes for transplanting when they are 3 or 4 inches high, and others form in their places, so that in all 2 to 4 "draws" or crops of sets are obtained. A bushel of medium sized sweet potatoes will produce from 3000 to 5000 sets if they are removed twice. It requires from 5000 to 10,000 sets to plant out an acre, so that the amount of seed required per acre will vary from 1½ to 4 bushels. For the late plantings, cuttings 12 to 14 inches long taken from the young vines after they have started growth may be used. It requires from 90 to 100 days for a crop to mature from vine cuttings. As good crops are produced as from sets.



SWEET POTATO FIELD

In Mississippi the most favorable returns were secured in tests with the Porto Rico variety by spacing the plants 12 inches apart in rows 3 to 4 feet apart, while the case was not quite so clear with the Triumph or starch variety. Where a 6-8-4 or 4-8-4 formula for fertilizer was used, the application of 1000 or 1500 pounds per acre was little if any more profitable than 500 pounds. The extreme sensitiveness to cold was noted in these experiments, forcing the conclusion that sweet potatoes which are to be used for seed should be harvested before any frost occurs. It was found that if they were chilled even by temporary exposure to temperatures below 40 degrees F. they might not sprout.

W. D. Kimbrough, in reporting his experience in Louisiana, emphasizes the point that highest yields are obtained by setting plants in the fields between April 15 and May 15, or as soon as danger from cold is past. "Total yield is not as important when growing table stock as the yield of marketable potatoes. Total yield, however, is the important point in the production of sweet potatoes for feed or starch, for the price per bushel is lower on this type of potato and a high yield must be produced to give good returns to the grower. Jumbo potatoes and the whole crop except strings and decayed roots may be used for feed and starch."

While this crop adapts itself to a variety of soils and degrees of fertility, the sweet potato grows best on a warm, fertile, sandy soil; but all soils are used, including clays. Sticky or colored soils injure the appearance of the roots for marketing, and should be avoided. The soil should be put in good condition by fertilizing with well-rotted barnyard manure. This should be supplemented with commercial fertilizers when the crop is grown for market. Starnes recommends a formula composed of 640 pounds high grade acid phosphate, 260 pounds nitrate of soda and 100 pounds sulphate of pot-

ash. This should be mixed and applied at the rate of 1000 pounds per acre. Where barnyard manure is not available, or too expensive, the ground can be put in good condition by plowing under green crops like crimson clover, peas etc. Dried blood and cotton seed meal have been found preferable to nitrate of soda in many localities. On soils well supplied with organic matter nitrogen in the fertilizers applied may be omitted, but potash is especially desirable, and phosphoric acid in a less degree.

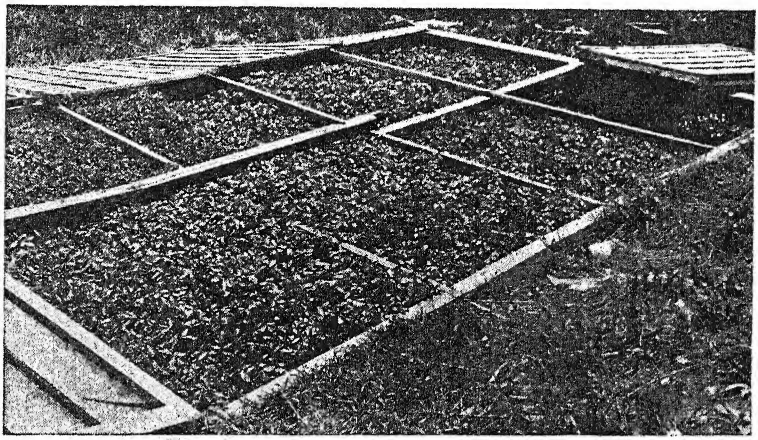
The soil should be well prepared before the sets are put out. Truck farmers on sandy soils usually plow but 3 or 4 inches deep for the early crop, claiming that they get short, better shaped potatoes thereby, but the heaviest yields are obtained by deeper preparation.

Sweet potatoes contain from 14 to 25 per cent of starch, some sugar, and other nutrients which recommend them for the table as vegetables, in pies and for canning as well as feed for hogs, cattle and horses.

Sweet potato plants affected with stem rot wilt, turn yellowish and the roots show a black ring just under the skin. Black rot, another disease of this crop, causes black canker spots to appear on the tubers. The best preventive against these ills consists in using only clean, healthy roots as seed for the production of shoots for planting. Damage from the sweet potato weevil, a small beetle with green head and red thorax, that tunnels through the roots, may be minimized by removing and burning all old trash and vines about the garden, and planting the next crop in another part of the garden.

TOMATO (*Lycopersicum esculentum*)

The tomato is one of the most universally popular crops for the home garden, is grown commercially on at least 200,000 acres for the fresh fruit market, and on 455,000 acres or more for canning and juice, 2¾ million tons being used yearly for that purpose. As a greenhouse crop it shares top honors with lettuce and cucumbers, about 90 per cent of the space in glass house ranges being devoted to those three crops. Tomatoes are on the market the year round. The early crop comes from the west coast of Mexico, Bermuda, Cuba, the Southern States and the greenhouses of the northern and eastern States, particularly around Providence, Hartford, Rochester, Buffalo, Astabula, Cleveland and Toledo.



TOMATO COLD FRAME IN NEW HAMPSHIRE

Large investments are required in greenhouse production in buildings, equipment and heating. But with care the greenhouse grower is able to compete with the outdoor producer 2000 or more miles away, who must expend large sums for packing and transportation. Of the early crop, greenhouse tomatoes ripened on the vine are much superior to tomatoes grown outdoors in far distant centers and picked green in order to get them to the consumer without great loss from bruising and rot.

Tomatoes occupy the soil of greenhouses for only a part of the year. For this and sanitary reasons a rotation of crops is desirable. These rotations usually con-

tain tomatoes, lettuce and cucumbers. In one of these plans tomatoes occupy the space from July 1 to December 15, lettuce from December 15 to March 31, cucumbers from April 1 to July 1. In ordinary greenhouse practice the plants are trimmed to a single stem which is trained to a string tied in the roof of the house. The Oregon Experiment Station has demonstrated that artificial pollination of tomatoes is highly important for increasing the yield and earliness of tomatoes.

South may be allowed to grow up to grass after the fruit is harvested, and the grass may be cut for hay or turned under, or tomatoes may be followed the same year with peanuts, velvet beans, cowpeas or sweet potatoes. In Indiana, where much of the field tomato crop is pruned and trained to stakes, Kentucky Wonder beans are planted and trained up the same stakes as soon as the early tomatoes are harvested.

Until recently, in Michigan most of the

MARGLOBE TOMATOES IN SOUTH CAROLINA

With field grown tomatoes a rotation is necessary. Tomatoes should not follow tomatoes without an intervening crop, and the rotation must not include peppers, eggplant or potatoes, since these plants are carriers of diseases to which tomatoes are susceptible. Ground cherry or other weeds related botanically to the tomato should be eradicated in the vicinity of the field. Mosaic and streak diseases are spread from tobacco and, according to investigations in New Jersey, no tobacco user should handle tomato plants. "If a person touches cigarettes, pipe tobacco or chewing tobacco and then touches a tomato plant mosaic disease may develop." Good yields and escape from disease are the main goals at which to aim in planning a rotation which may have to be as long as 4 years or even much longer, depending on the prevalence of tomato diseases in the soil. The early tomato fields in the

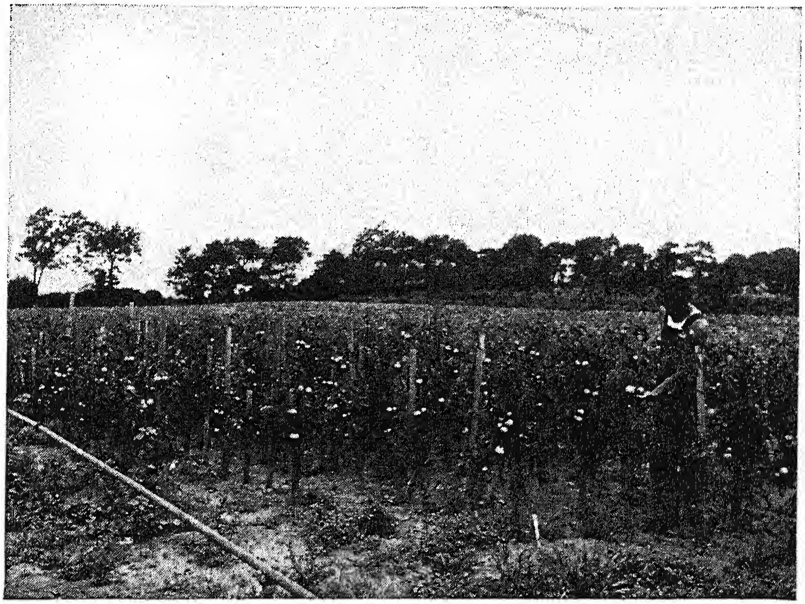
young plants used in growing the crop for canning tomatoes were produced in the South and shipped north in time for setting out in the field. Delays in shipments and injury to the plants during transportation, forced a serious study of a plan for producing home grown plants more cheaply. Success has been attained. About 200 plants are required to set an acre. A cheap plant bed built of scrap lumber and lath, heated by manure and covered with muslin, especially if located on the south side of a building, furnished the necessary conditions. Seed planted the third week of April gave plants ready to set out by the end of May.

Good seed is one of the first essentials in success with tomatoes. Never use miscellaneous canning factory seed. Two ounces of seed will produce enough plants to set an acre. Many seed dealers have selected seed which will produce a crop

showing uniformity of size, shape and stage of maturity, qualities which are of large importance on the market. In regions where fusarium wilt is prevalent it is worth while to plant only seed from immune varieties of which Marglobe is perhaps most widely known.

For the home garden in the Northern States the seed may be sown in the hotbed or kitchen box about March 15 and the plants should be ready to set out about May 1 to 15. The seedlings do best if transplanted once before being set in the open garden. They may be set 4 or 5 inches apart in a cold frame where they may be allowed to develop into good strong plants 12 inches high with sturdy stem, side branches and a number of blossoms when they are ready for final transplanting.

Soil and Fertilizers. A rich, warm sandy loam soil is best for the early crop of tomatoes. When the crop is grown for canneries a medium clay loam will give larger yields. Any good potato soil will also produce a good crop of tomatoes. From the results secured at the stations it is shown that heavy applications of stable manure or complete fertilizers are very desirable for this crop. The tomato particularly demands large amounts of potash and nitrogen. Stable manure is essentially a nitrogenous manure and should be supplemented with heavy applications of muriate of potash, ashes, kainit, or like potash fertilizers and a smaller amount of acid phosphate or ground bone to supply phosphoric acid. Voorhees recommends for soils already in good condition a mixture of 400 pounds nitrate of soda, 700 pounds bone tankage, 400 pounds acid phosphate and 500 pounds muriate of potash applied at the rate of 500 pounds per acre. In the field culture of tomatoes it is desirable that they follow some well-manured crop, especially a hoed crop or clover.


TOMATOES TRAINED TO STAKES

The ground for tomatoes should be prepared early either by fall or early spring plowing and put in fine tilth. The plants should be set in the field just as soon as danger from frost is past. On rich garden soil the plants are set 4 to 5 feet apart each way and 6 inches deep; in field culture they are put 3 to 4 feet apart each way. When set 3 by 4 feet it requires 3630 plants per acre.

Insects and Diseases: Cut Worms are the bane of the home gardener and the young tomato plant is on the menu of every cut worm. Poisoned bran is the best medicine for him, containing 1 pound of arsenic and 2 quarts molasses mixed with 25 pounds of bran and moistened with 4 gallons of water. This bait is to

be scattered along the rows late in the evening.

The TOMATO HORN WORMS are the familiar fat, green worms about 4 inches in length which devour the leaves. The adult that lays the eggs is a large handsome, night-flying moth. When they do not succumb to the parasites which usually attack them they may be controlled by spraying with calcium arsenate.

The FLEA BEETLE does damage in the seed beds. This pest may be successfully combatted by spraying with Bordeaux mixture or dusting with powdered derris root.

DAMPING OFF disease of seedlings may be held in check by dusting the seed with red oxide of copper at the rate of 1 ounce of dust to 10 ounces of seed, or by dipping the seed for 5 minutes in a 1 to 1200 suspension of 5 per cent ceresan or by applying formaldehyde dust (6 per cent formaldehyde mixed with charcoal) to the seed bed at the rate of 8 ounces to a bushel of soil.

Such diseases as early and late blight, bacterial canker and bacterial spot are largely prevented from doing serious damage by soaking the seed for 10 minutes in a 1 to 3000 solution of bichloride of mercury in water.

MOSAIC disease is to be recognized by a yellow mottling of the foliage. It may be carried by plant lice or by handling with contaminated hands, especially tobacco smokers. There seems to be no effective remedy. Clean cultivation and keeping the young plants away from all known sources of infection are to be observed.

TURNIP (*Brassica rapa*)

The turnip is chiefly grown in the United States as a table vegetable and only in limited amounts for stock. As a stock food it is about on a par with rutabagas, beets or silage, but cannot be so cheaply grown as silage. In garden culture the seed may be sown either very early in spring and an early summer crop secured, or later in July and August for winter storing. The plant is not easily injured by frost and makes its best growth in cool, moist weather. For early use plant in rows 1 to 1½ inches deep and 12 to 18 inches apart. The plants are thinned to stand about 4 to 8 inches apart in the row, depending on the varieties grown. In field culture the rows are often 30 inches apart to facilitate horse cultivation. The seed is sometimes sown broadcast from July 20 to August 1, when the crop is grown for stock. Two to 3 pounds of seed are required per acre. The crop is harvested upon the approach of freezing weather, the tops cut off and the roots

FIELD OF TURNIPS

stored either in pits or cellars. They sprout readily and should be kept as cool and dry as possible. A yield of 1000 bushels per acre is sometimes obtained on rich land.

Varieties. The Globe varieties are considered best for the main crop and for fall and winter use. Some of the best garden varieties are Early Flat Dutch, Purple Top and White Top Strap Leaf.

Enemies. *See Cabbage.*

WATERMELON (*Citrullus vulgaris*)

The 20 chief watermelon States are reported as shipping about 40 thousand carloads of this fruit annually. The commercial crop occupies about 270,000 acres, Georgia, Texas, South Carolina, Florida, North Carolina, Alabama, Oklahoma, Missouri and California being the heaviest producers.

The plant is a trailing annual sensitive to frost. It is a native of Africa, but is now more largely grown in the United States than anywhere else. It flourishes especially in the warm, sunny regions of the South and West. Good watermelons for home use, and to a limited extent for market, are grown as far north as Canada.

The watermelon grows best on rich, warm, sandy loams that are well drained. If possible, a southern slope should be chosen for the early melons. It is desirable in growing watermelons for market that they follow a crop of clover or cowpeas. They should be rotated with other crops and should not be planted on the same ground again for 3 or 4 years. If the soil is poor it may be put in good condition by plowing under a heavy application of barnyard manure in the fall. The spring preparation of the land consists in thorough cultivation at intervals of 3 or 4 weeks before the seed is planted. This is for the purpose of germinating the weed seed and of putting the soil in the best physical condition. In Georgia the station states that rather shallow plowing, followed by thorough pulverization with the disc harrow, is practiced.

Melons should not be planted until all danger of frost is over. In States as far north as Michigan and New Hampshire this will not be before May 20 to 31. Watermelons are planted in hills about 10 feet apart each way. According to the New Hampshire Station, one of the most successful watermelon growers in that State digs each hill 8 to 10 inches deep and 18 to 24 inches across and fills them ⅔ full of rich, well-rotted manure. "Enough soil is drawn on this and thoroughly mixed with the compost to fill the hill nearly full. A half-pint of unleached wood ashes or fine hen manure, or a small handful of phosphates is sprinkled over the top soil and well mixed with it, after which soil is added to make the hill level with the top of the ground." From 10 to 12 seed are scattered throughout the hill and covered 1 to 1½ inches deep. Cultivation consists of thorough shallow tillage, with a loosening of the soil about the plants whenever it becomes compact. After the plants have become thoroughly established and danger from insects is past, they are thinned out to about 3 of the most vigorous in each hill.

The more modern method of watermelon culture is to plow out the rows one way; fill the trenches with manure, thoroughly mix the manure with the soil in the trenches by running back and forth with a scooter plow; then throw the soil back again and plant the seed on the bed thus formed. This is a more commercial way of preparing the ground than by the old method of individual hill preparation. The hills may be planted 10 feet apart each way or the rows made wider apart and the seed planted closer together in the row.

Where stable manure is not available for watermelon growing the Georgia Station recommends the following mixture of commercial fertilizers: Nitrate of soda, 400 pounds; high grade acid phosphate, 800 pounds; muriate or sulphate of potash, 200 pounds. This should be mixed and applied at the rate of 700 pounds and upward per acre. For later melons a mixture of 800 pounds cottonseed meal, 800 pounds high grade acid phosphate and 800 pounds of kainit per acre may be used.

In order to control diseases of this crop, watermelons should be grown in long rotations in which watermelons appear only once in 8 or 10 years. In the North the intervening crops may be corn or wheat followed by pasture or clover and meadow. In the South, cotton, peanuts, winter oats, corn, velvet beans and cowpeas may be used in the rotation.

No special directions can be given for recognizing with certainty when watermelons are ripe. Some of the indications are as follows: A dead sound when thumped with the finger; a yellowish appearance underneath; the drying up of the tendril or curl opposite the place

where the melon is attached to the vine, and finally, if the melon yields somewhat, emitting a kind of crackling sound when firmly pressed downward with the palm of the hand, it is almost certainly ripe.

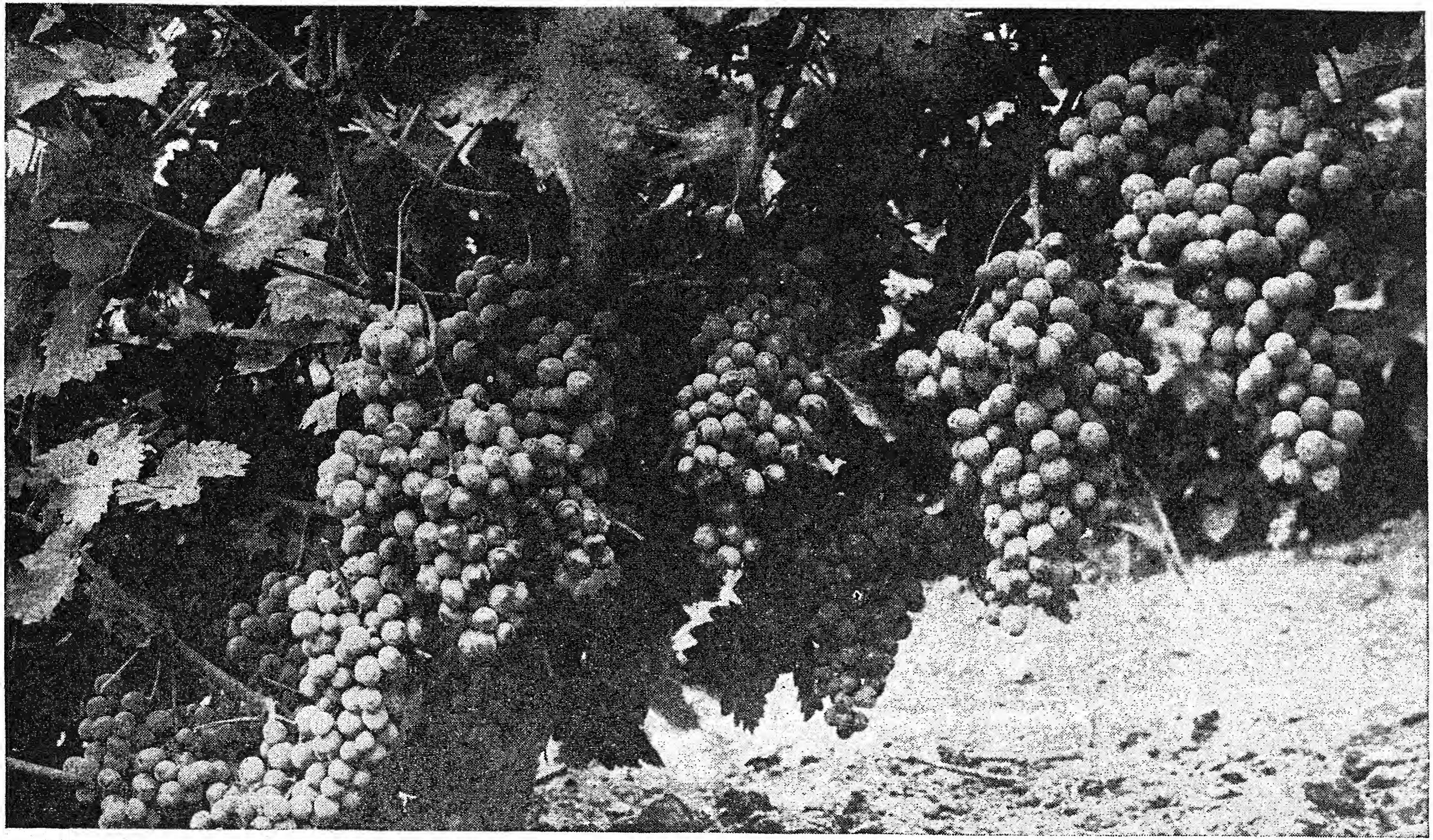
Kleckley Sweet, Stone Mountain and Tom Watson are popular varieties for the home garden.

The **Citron** is a variety of watermelon used for preserving. It is inedible in the raw state.

Stock Melons or pie melons are a kind of non-saccharine watermelon sometimes planted in corn fields like pumpkins for stock. The fruits weigh 20 pounds or more. They have been grown to a considerable extent in Kansas and Oklahoma for stock.

PART III

FRUITS AND NUTS



FLAME TOKAY GRAPES

FRUITS AND NUTS

HOME FRUIT GARDEN

No farm is complete without a suitable area near the home devoted to fruit production for family use, fresh and canned. The fruit garden should not be such a stingy little plot as to be wholly inadequate, nor so large as to interfere with more important farm work. A neglected, unkempt fruit patch full of weeds, petered out strawberry plants, decrepit raspberry canes and scraggy untrimmed apple trees, is a distressing sight and of little use. If the fruit garden is unduly large and the chosen varieties too subject to bugs and diseases, enthusiasm may wane as the heat of summer and other troubles with fruit enemies increase. But good fruit in desired quantity cannot be obtained without effort and it is well worth the effort. Perhaps the most reasonable plan is not to undertake too large a garden task and to plant varieties which do not require too much constant attention to spraying and other special operations. As a possible selection of varieties the Department of Agriculture recommends the following list for northern Pennsylvania and the highlands of Maryland, Ohio and West Virginia.

ALMOND (*Prunus amygdalus*)

The extremely early blossoming habit of this nut tree limits its culture to a very few favored localities. Practically all the almonds in this country are grown in California, though the belt of successful nut culture includes also portions of Arizona, Utah, Nevada, New Mexico and southwest Texas. There are about 5½ million almond trees in bearing. The tree itself is nearly as hardy as the peach, and while it blossoms abundantly and is often grown as an ornamental, it seldom bears fruit in Eastern United States. It succeeds best on rich, well-drained sandy or gravelly loams, in hill locations or on high bench lands. While the tree will withstand drouth perhaps better than any other cultivated fruit, profitable crops of nuts are secured only where the rainfall is sufficient or where water for irrigation is available.

The almond is propagated by budding on seedling bitter almond stock. Shield budding as with the peach, is most practiced. Trees should be set at least 24 feet apart each way and the orchard given shallow and thorough cultivation. Cutting back trees at transplanting time to

(NORTHERN PENNSYLVANIA AND HIGHLANDS OF MARYLAND, OHIO, AND WEST VIRGINIA)

Fruit	Variety	Month ripe	Plants	Length of row
			Number	*Feet*
Strawberry	Howard 17 (Premier)	June	50	100
	Catskill	June to July	50	100
Raspberry	Latham (red)	July	20	50
Grape (in favorable locations)	Delaware	August	3	24
	Niagara	September	3	24
	Concord	....do	3	24
Cherry	Montmorency	July	2	30
Plum	Imperial Epineuse	August to September	1	15
	Reine Claude	....do	1	15
	Stanley	September	1	15
	Shropshire	....do	1	15
Pear	Gorham	....do	1	20
	Seckel	....do	1	20
	Bartlett	....do	1	20
Apple	Lodi	August	1	30
	Wealthy	September	1	30
	McIntosh	....do	1	30
	Jonathan	September to October	1	30
	Golden Delicious	October	1	30

1 foot from the ground and forming the head of three main branches at this point has been found a very satisfactory practice.

In pruning, almonds should not be shortened in, as with the peach and apricot, since most of the fruit is borne on the slender outer branches and short fruit spurs on the inside of the trees. The tree is shaped during the first 3 years, after which only dead and crossed branches will need to be removed. Summer pruning should be avoided.

The trees bear in from 2 to 4 years from budding, but full crops are not secured under 7 or 8 years. The most popular varieties at the present time are Nonpareil, Paper-shell, Jordanolo and Harpareil. About ¾ of the acreage in California is planted to the first 2 varieties named. Trees should be mixed in orchards to insure fertilization of the fruit.

Methods of bleaching almonds to take the place of the objectionable practice of sulphuring, have been investigated by the California Station. Very satisfactory results were obtained by the following method: The nuts were placed in a cane or splint basket and dipped for about 5 minutes into a solution containing, to every 50 gallons of water, 6 pounds of bleaching powder and 12 pounds of salsoda. "They are then rinsed with a hose, and after draining dipped into another solution containing 1 per cent of sulphate of lime. After the nuts have assumed the desired tint they are again rinsed with water and then dried. Instead of the second dipping, the nuts may be sulphured for 10 or 15 minutes. The cost of 50 gallons of the chlorin dip will be about 40 cents; the same bulk of the bisulphate dip probably considerably less; the time occupied in handling 1 batch—2 dips—12 to 15 minutes."

Enemies: LEAF BLIGHT (*Cercospora circumcissa*) is especially injurious in California. The disease attacks the leaves and small twigs, causing the leaves to fall prematurely. The leaves become infected from spores which pass the winter on twigs of the previous season's growth. The leaves on the outer branches are first attacked and the disease gradually spreads toward the center of the tree. Discolored spots appear on the leaves, and later the affected tissue dies and falls out, leaving small holes in the leaves. The twigs are similarly attacked and pits are formed in the bark. For combating the disease the trees may be sprayed with Bordeaux mixture, before blooming, when the trees are in full leaf, and again about a month later.

The almond is not infested with any special insect pest not common to other fruit trees. It is often attacked by tree hoppers, locusts and scale insects, especially San Jose scale. For other insect enemies *see Related Trees.*

APPLE

The apple is the most important fruit raised in the United States. There is no State in which there are no family apple orchards, and apples are grown commercially in 40 States. According to the census there are 82½ million bearing trees in the country. The total commercial crop now runs around 126 million bushels. Washington, New York, Virginia, Pennsylvania, California, Michigan, Ohio and Oregon are the leading apple States. Temperature and moisture are the limiting factors in the distribution of the apple. To the north it extends into Canada along the Atlantic and Pacific coasts. But in the high interior plains it is likely to winter-kill or fail to bear, and even in the Dakotas and Montana only the hardiest varieties thrive except in a few protected valleys like the Bitterroot and Flathead. In much of the Great Plains area apple growing is precarious by reason of frequent drouth and extreme cold and dry winter winds.

Nor do apple trees thrive in regions of long hot summers with only mild winters. For normal behavior the apple requires a resting period forced upon it by cold weather when the leaves drop and the tree enters into a completely dormant stage. Even in experiments by apple breeders in growing seedlings from seeds obtained by cross breeding it has been found that the seeds do not germinate well unless they have been subjected to freezing temperatures. At the other extreme in tropical and subtropical climates the apple tree behaves as an evergreen, holding its leaves and showing buds, bloom and apples in all stages of growth at the same time with no regular periodicity of harvest.

A fertile soil and good drainage are prime requisites for an orchard site. Apple trees demand an abundance of plant food in the soil. In many localities also there is a preferred slope of land with reference to sun and barriers against prevailing winds. In the two apple regions of Kansas,—Doniphan County and the Arkansas Valley—growers consider an

east or north slope better than a west or south slope, and that windbreaks on the west and south sides are highly desirable. The same considerations may hold good in other regions with proper adjustment to slope and wind direction of each locality.

Since most apple trees are self-sterile, apple varieties should be planted in blocks not over 4 to 6 rows wide of one variety, each block being separated from the next block by 2 or 3 rows of an actively pollenizing variety. Kansas growers have found that the Winesap group,—Black Twig, Stayman and Delicious—do not cross pollinate well. For a 30 acre orchard in Doniphan County with a total of 665 trees an allotment of 350 for Jonathan, 175 for Winesap, 70 for York, and 70 for Rome or Golden Delicious, leaving room for about an acre of early apples is recommended.

In Colorado apples thrive best on deep clay or silty loam. The site for the orchard should be on land slightly higher than the surrounding country, thus providing both soil and air drainage. North slopes will delay blooming and may help in preventing too much trouble from late spring frosts. Colorado growers find it desirable to thin the crop after the June drop, removing all blemished or wormy apples and terminal fruit on long weak twigs, then thinning the rest of the fruit so as to space the apples 3 to 8 inches apart. According to E. P. Sandsten "there is a definite ratio between the number of leaves on a branch and the number of fruit that should be left. This ratio affects quality and size of fruits. With the apple the number of leaves need to produce one good-sized fruit will range between 40 and 80."

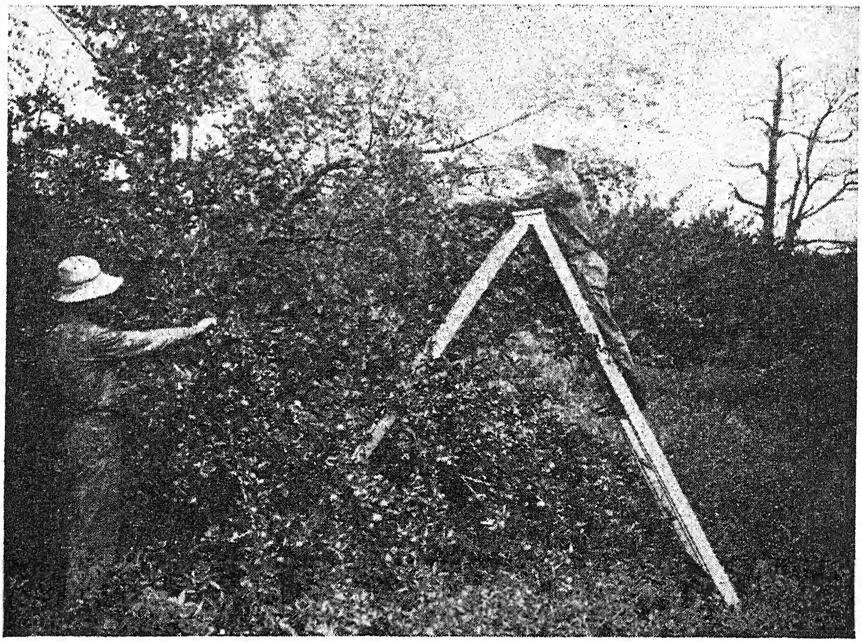
APPLE ORCHARD IN MAINE

The nation wide distribution of apple growing has made necessary a careful study of the adaptability of varieties to the varying climatic conditions in different parts of the country. A ten-year study of these problems from 146 varieties by the Ohio Experiment Station established certain facts regarding the connection between the period of bloom and yield of apples. In general it was found that low temperatures in March and April were associated with heavy yields. The average date of full bloom varied from May 3 in the Success Crab to May 11 in the Thurso apple, the average date for standard varieties being May 8. Damage from frost injury occurred in years when full bloom was reached before May 1. The average length of the blooming season was 8 days, a period long enough to allow overlapping of early and

late varieties to provide for cross pollination.

In New England and adjoining States it was for generations taken for granted that rocky, poor soil, unsuited to any other crop, was good enough for apples, and the trees were unfertilized and otherwise neglected. When it became evident that the plant food requirement of the apple must be taken into account, attention was directed toward forcing a more mum requirements for a satisfactory apple soil are good aeration throughout a depth of at least 4 feet below the surface, moisture-holding capacity in the upper 4 feet of soil to tide the trees over a summer drouth period of 4 weeks or more and the capacity to hold the application of plant food during most of the growing season."

In the regions of the Pacific Coast and Rocky Mountain States, where irrigation



THINNING APPLES

vigorous growth and hastening maturity. In these efforts resort was had to the use of nitrate of soda and other quickly available nitrogen carriers. The Vermont Experiment Station has found that the application of soluble nitrogen while beneficial within limits, may easily be overdone. "When orchards are thus treated, rapidly grown and tender foliage is apt to fall a prey to attacks of apple scab. The rate of application depends on the age of the tree and on soil requirements. On many soils 1 or 2 pounds of nitrate of soda to a young tree, or 5 to 10 pounds to older bearing trees, have been deemed sufficient."

In New Jersey it has been shown that a sandy subsoil possesses too little moisture-holding capacity to sustain apple trees during severe drouths. "The mini-

is practiced, the custom formerly prevailed to a greater degree than today, to space apple plantings with reference to fillers of peach or intercrops, planning later to pull up the short-lived peach trees as the apple trees neared full size. The plan suffered from the disadvantage that the filler trees required different irrigation treatment from the apple. This objection can be met by planting the same variety as fillers. If apple trees are planted 20 feet apart in squares, and if, at the age of 15 years, alternate trees are removed, a hexagonal system will be the result. The spacing of standard varieties of apples, when fillers are not used, is ordinarily 25 to 40 feet.

In the Wenatchee apple district of Washington the first irrigation is given in late April or early May followed by 3

or 4 applications at intervals of 20 to 30 days. At Montrose, Colorado and Payette, Idaho, water is applied 3 to 5 times per season beginning about June 1. In the Bitterroot Valley, Montana, young apple trees are irrigated earlier and oftener than bearing trees. Harmful results may follow allowing apple orchards to enter the winter in a dry condition. In cold climates irrigation in late fall, after the trees are dormant, may help to prevent winter-killing. In Arizona and the Pacific Coats it may be a good policy to apply available water in winter, thus utilizing the deep soils of these areas as water reservoirs for use by the trees in early spring.

Where cover crops are used under irrigation conditions, care must be exercised to prevent the cover crop from competing too much with the apple trees for moisture. Thus in the Yakima Valley, Washington, where most of the yearly precipitation occurs in winter, alfalfa, sweet clover and vetch are grown in winter and then turned under in the spring. Similarly in California and the Southwest vetch and sweet clover are favorite winter cover crops. The usual intercrop grown between the rows of non-bearing irrigated orchards are strawberries, corn, squash, potatoes, alfalfa, tomatoes, cotton, lima beans and even peach and cherry trees. About 2 feet of water is applied annually in addition to the natural rainfall of these districts.

In all parts of the country neglected apple orchards are to be seen which are eyesores in the community. Whether or not they are worth renovating depends upon whether the orchard is rightly located and on good soil, whether the varieties are suitable, and how badly diseased, misshapen and deteriorated the trees have become. If the outlook is hopeful old neglected trees may be pruned so as to let in more light at the top and keep the fruiting branches within reach of ordinary ladders. Suitable fertilizers and spraying may then result in reasonably good crops of fruit. Barnyard manure, acid phosphate and muriate of potash are recommended, together with the use of nitrate of soda or sulphate of ammonia if quick results are desired.

Practically all the earliest orchards in the U.S. were seedling trees. Apple seeds were carried west by the original settlers or Indians and from the millions of trees scattered along fence rows and lines of migratory travel, superior seedlings were selected and most of the commercial varieties have been developed from these seedling trees. In the early 1800s farmers began to propagate especially promising seedlings by grafting, and thus fixing types or varieties.

Variety names of apples are legion, over 4000 having been cultivated, but only a few leading sorts for each apple region can be mentioned in this account. In the central Atlantic section, York, Stayman Winesap, Delicious, Rome Beauty, Ben Davis, Grimes Golden and Jonathan head the list. In the Ohio Basin the same list, with the exception of York Imperial, prevails. In the Southwest Ben Davis, the former leader, has greatly declined and is now superseded by Jonathan, Delicious, Winesap and Grimes Golden. For the North Central region, Lake Michigan, Jonathan and Grimes Golden are recommended. In Washington, Delicious, Winesap, Jonathan and Yellow Newtown are the favorites, while in Hood River Valley Yellow Newtown tops the list, followed by Delicious, Rome Beauty and Ortley. Jonathan stands first in Utah.

Taking the country as a whole, according to J. R. Magness, the 6 leading varieties in 1928 were Delicious, Winesap, Jonathan, Baldwin, Stayman Winesap and Ben Davis. Since that time Ben Davis has lost ground tremendously by reason of the prolonged drouth since 1930, and it has been estimated that 2,000,000 Baldwin trees were killed in New England and New York in the severe winter of 1933-34.

Root-Grafting. Experiments at the Kansas Station with various lengths of cions and different portions of roots for grafting showed that the difference of growth in favor of the longer cions and stocks is probably not sufficient to compensate for the extra labor and expense made necessary by their use. Cions about 6 inches long grafted on piece roots 3 to 5 inches long will make as good trees as longer cions grafted on whole roots. It was also shown that where the graft is buried deeply in the soil, a new system of side shoots will take the lead at about the usual depth below the surface of the soil, to the more or less complete dwarfing of the lower and earlier root system.

Root vs. Top-Grafting. The relative effects of top-grafting and root-grafting on the longevity of some varieties of apples have been studied by the West Virginia Station. With the King variety all the root-grafted trees were dead at the end of 10 years, while the top-worked trees were in a fairly good condition 20 years after being worked. With the Wall-

dow variety all of the top-grafted trees were living and in a thrifty condition at the end of 20 years, while the root-grafted specimens were all dead, except 1 branch of 1 tree. Tallman Sweet is recommended by the station for double-working trees, i.e., seedlings root-grafted with Tallman Sweet and then top-worked with the variety which it is wished to propagate.

In summing up the evidence and best practices of apple growers in Delaware, Professor Powell states that a few apple growers are planting a hardy, vigorous, straight growing variety as a stock on which to top-work a permanent orchard. It is claimed for this method that it provides a healthy, strong trunk for all varieties, corrects the poor growth of some, overcomes the tenderness of others in the far north, and sometimes makes a stronger system of roots. This method also gives the grower a chance to select the buds or cions from trees of steady productiveness, hardy foliage and highly colored fruit,—factors of the greatest importance in commercial orchards.

Location and Soil. The ideal location for an apple orchard is on a gentle eastern or northeastern slope which enjoys both air and water drainage. These latter are essential factors in the commercial success of the apple orchard. Modern experience has shown that no soil is too good for the apple. Sandy lands and low, flat meadow locations should be avoided. Newly cleared timber lands, limestone soils and loamy clays are especially desirable for apples, and in a suitable climate insure satisfactory results. Apples in quantity sufficient for home use can be grown practically anywhere in the United States where ordinary farming can be carried on. The apple orchard should be deeply plowed and thoroughly cultivated before the trees are planted therein.

Planting the Trees. One or 2-year-old trees are better for setting out than older stock. Spring planting, on the whole, is safer than fall planting and is quite generally recommended for the whole country. The trees should stand from 32 to 40 feet apart each way in the orchard. The greater distance is recommended for the most vigorous growing varieties.

Cultivation and Cover Crops. Starting from the first year after setting out, the orchard should be plowed deeply every spring. This sends the roots downward where they are needed in time of drouth. Fall plowing, though sometimes practiced to induce earliness, is not generally advisable. For the first 4 or 5 years, cultivated crops, like potatoes, corn or small fruits, may be grown between the rows. On steep hillsides also where cultivation is impracticable clover or alfalfa may be seeded. Where orchards are kept in grass the grass should be mowed and left to lie in place under the trees to rot. Sometimes very good results are secured in orchards treated by the latter method, but generally clean cultivation until midsummer each year, followed by some cover crop will give the best results.

The primary objects of orchard tillage are to make more available the plant food of the soil and to conserve the soil moisture to the use of the trees. Experiments in Missouri show that trees that are well cultivated make a more uniform and vigorous growth, are healthier, produce better fruit and are less unfavorably affected by drouth than those not cultivated.

Orchards given clean cultivation at the Kansas Station one season contained 16 per cent of moisture when the orchard in grass contained but 6 per cent. At the Nebraska Station a cultivated orchard contained 20 per cent of moisture when an orchard in grass contained but 14 per cent. Generally speaking the most serious injuries to orchards occur when crops are planted in them that sap the soil moisture early in the season like grasses and the cereal grains. Potatoes, beans and like vegetables that cannot be planted until later in the spring are distinctly less injurious. When orchards are in full bearing no crop for profit should be grown in them at all.

At the present time practical horticulturists recommend, and station experiments confirm, the practice of thorough tillage of the orchard until July or August, then seeding the orchard down to some nitrogenous cover crop, like red or mammoth clover, vetch, cowpeas, alfalfa or crimson clover. Rye is a favorite cover crop on lighter soils. In wet years cultivation should cease earlier in the season in order to give the trees plenty of time to mature their wood growth before winter sets in. These cover crops, when plowed under the following spring, add humus to the soil, improve its mechanical condition and increase its capacity to hold soil moisture. They also protect the ground over winter from alternate freezing and thawing and from freezing so deeply.

Manuring. In the fertilization of orchards potash is generally the most important element to be applied, particularly after the trees have reached bearing

age. On the farm this can be best supplied in the form of unleached wood ashes, from 40 to 50 bushels per acre being applied to bearing trees each season. The ashes also supply a certain amount of phosphoric acid and lime, which are necessary in fruit and wood production. Where good wood ashes are not obtainable, from 500 to 700 pounds per acre of muriate of potash may be used in mature orchards. Next to potash in importance in most orchards is nitrogen, and this can be best supplied in well-rotted barnyard manure. Nitrogen is especially valuable in promoting wood growth and in rejuvenating old, worn-out orchards. It can be safely and advantageously used in all old farm orchards. It is generally thought that when mature or bearing trees do not make a foot or more of growth upon all shoots, or when the tree matures early in the season and the leaves have a yellowish appearance, nitrogen is needed. If, however, the trees make a strong, vigorous growth each season, and the leaves are of good size and dark color, the free use of nitrogen manures is likely to be more harmful than beneficial. In such cases the legumes should not be used as cover crops. In commercial orchards the cheapest method of supplying nitrogen to the orchard is by cultivation and the use of nitrogenous cover crops each season, as noted above.

Pruning. Apple trees are pruned primarily for the purpose of forming a symmetrical, evenly balanced head, and for the admittance of sunlight and the free circulation of air. All dead limbs, and limbs that rub against each other, should be removed, care being taken not to leave the limbs and trunks exposed to the direct intense heat of the sun's rays, which frequently causes the disease known as sunscald. The value of light in the production of fruit buds was studied at the Rhode Island Station, and it was found that there was a much larger number of clusters of fruit buds upon limbs that grew in sunlight than upon similar limbs from the same tree that grew in shade. This would seem to indicate the value of so pruning that light may be admitted equally to all portions of the tree. In the Central and Eastern States the head should be formed 2 or 3 feet from the ground and trained to a round, open form. Pruning can be best done in late winter or early spring. Besides thinning out the dense growths and crossed branches, all side branches that are making too strong a growth should be checked by heading in. Most of the pruning and formation of the tree should be done while it is young. Trees pruned to a vase or goblet form, by cutting out the central stock or leader, have been found most desirable in California.

Utilization of Waste Apples. Apples which are of too poor a grade to be marketed can be profitably used for evaporating, or making into jelly, marmalade, cider and vinegar. With a hand grinder and press but little more than 2 gallons of cider can be obtained from a bushel of apples. By the use of a medium sized horse power grinder and press 4 gallons of cider can be easily obtained from a bushel of apples. Good cider jelly can be made by adding about 1 pound of sugar to each 5 pounds of cider. This will make 40 pounds of jelly for each 100 pounds of cider. For apple marmalade a better quality of apples is required than for cider. A good quality of marmalade can be made by the use of 10 pounds of sliced fruit to each 4½ pounds of sugar and cooked down with 1 gallon of cider.

In evaporating apples a bushel of fruit will make on the average 6 to 7 pounds of dried product. A better quality of evaporated product will be secured if apples are used that are still firm and somewhat green rather than apples ripe enough for dessert. Some of the best varieties for evaporating are: Patten Greening, Baxter, Ben Davis, Golden Russet, Northern Spy, King, Ribston Pippin, Twenty Ounce and Pewaukee.

In making vinegar from fresh cider on the farm, the cider should be put in clean barrels and allowed to ferment. Under ordinary conditions it requires 3 to 7 weeks for the sugar in sweet cider to become completely converted into alcohol or before it becomes "hard cider." Under the influence of an acetic acid ferment hard cider is gradually converted into vinegar. This process is hastened if the depth of the liquid in the barrel does not exceed its surface measurement. Air should be admitted freely at all times and the barrel kept in a uniformly warm temperature.

From census figures it appears that the production of cider on farms amounts to about 13½ million gallons annually, and that over 200,000 farms report production on a considerable scale. The steps to be observed in making a good quality of cider have been summarized by the Department of Agriculture as follows: Select sound, ripened fruit. Blend several varieties if available. Wash fruit and dis-

card all partly decayed fruit. After grinding and pressing allow juice to stand in deep containers over night. Siphon off the juice from the sediment. Pasteurize the juice for 10 minutes at temperature of 170 degrees F. Store in cool place. For home use no further treatment is necessary.

General Scheme for Spraying Apple Trees. Apple scab and codling moth are the 2 worst enemies of apples in the Eastern and Middle States. These and most other serious apple troubles may be effectively controlled by 4 applications of a combined Bordeaux mixture and Paris green solution as described under Spraying. The first application should be made just before the flower buds open, the second just after the petals fall, and the third and fourth at intervals of 10 days to 2 weeks. The fourth may sometimes be omitted. In the following paragraphs directions are given for treating the more important apple enemies.

Enemies: BITTER ROT (*Gloeosporium fructigenum*) is perhaps most common on certain sweet varieties of apples. The fungus appears later than the apple scab. The disease is often associated with brown rot, and is not to be distinguished for practical purposes from black rot. The disease attacks any part of the apple and spreads rapidly. Bitter rot is to be recognized by the presence of numerous black pustules just under the skin of the apple in the older infected areas. Infected apples should not be packed with sound fruit. Trees should be sprayed with ammoniacal copper carbonate when bitter rot first appears, and again 2 weeks later.

RUST (*Gymnosporangium macropus*) is a disease due to a fungus which spends a part of its life cycle on the cedar, where it is the cause of the "cedar apples." In the early spring the cedar apples appear and spores are carried from these structures to apple and other related trees. Leaves infected with these spores develop orange spots on the under surface, and later cup-shaped bodies on the under side. In these cups spores are formed, which are blown away by the wind and reinfect cedar trees. The fruit of the apple is usually attacked about the same time as the leaves. In bad cases the leaves turn yellow and fall off. By destroying cedar trees in the vicinity of orchards the spread of the disease may be checked. Where this is impossible, the cedar apples may be gathered and destroyed and apple trees sprayed with Bordeaux mixture.

SCAB (*Fusicladium dendriticum*) attacks the fruit and leaves of apple and pear trees. On the leaves the disease is often called leaf blight. Black spots of considerable size are formed on the fruit. As the spots increase in size the diseased tissue cracks open, growth ceases, and the fruit becomes one-sided. The spots on the leaves are similar to those on the fruit, except that the edges are not white. The leaves are made to curl somewhat by the development of the disease. Scab is the most important fungus disease of apples, but the amount of injury varies greatly from year to year. For combating scab spray with Bordeaux mixture when the buds are swelling, again just before blossoming, and a third time after the flowers have fallen.

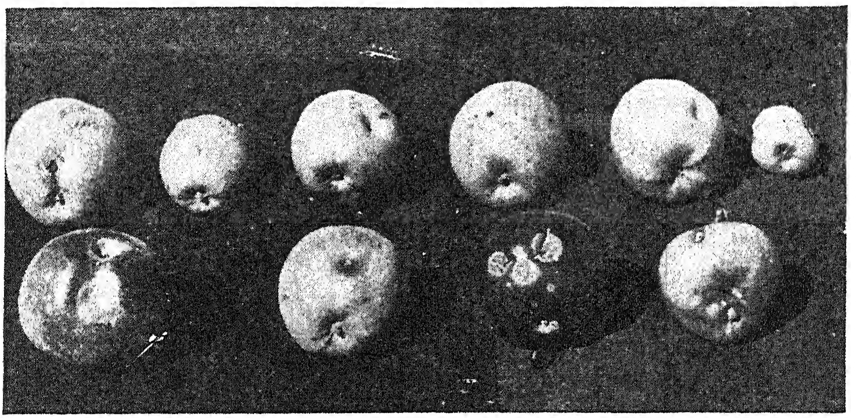
SUNSCALD is a term applied to a dying of the bark and growing tissues on one side of a branch or trunk. The trouble usually appears on the southwest side of trees in winter. In different localities different fungi are associated with the disease. The injuries are in part due to winter freezing, by which the bark is ruptured and the entrance of the fungi rendered easy. For preventing the trouble apple trees should be headed low and the trunks should be protected against the action of the sun by wrapping paper or other substance loosely around the trunk.

CANKER (*Nectria ditissima*) attacks the apple, beech, oak and other shade trees. The fungus gains entrance to the tree through wounds in the bark. As the disease progresses the bark cracks, often in such a manner as to girdle small branches. Later the wood is attacked. Usually a swollen ridge of bark is produced around the edge of the canker wound. Trees which have been destroyed by canker, and badly affected branches should be cut and burned.

CODLING MOTH (*Carpocapsa pomonella*) is about ½ inch across the wings. The forewings are gray crossed by brown lines. The moth usually flies at twilight or night. The eggs are laid on the surface of the apple, in the calyx, or on the leaves. After hatching, the caterpillar eats its way into the apple, either at the calyx end or on the side. Within the apple it grows to a length of ¾ of an inch, burrowing around the core and finally eating a hole to the outside. There are two broods annually, and perhaps a third brood in some States. The caterpillars of the second brood winter over in

the apple. The insect infests also pears and sometimes peaches and plums.

Spraying with arsenate of lead has long been the standard remedy against codling moth, the first application to be made just before the calyx lobes have closed, the second about 5 days after the moths begin to fly, the third within a few days after an increase in second-brood moths appears, with later sprayings at 2-week intervals if infestation is severe. Fluorine sprays have also been used, and more recently fixed nicotine sprays show promise as substitutes for both the poisonous insecticides. The slight danger to the consumer from arsenical residues on apples sprayed too near to harvesting time, made necessary the resort to mechanical means of washing apples and pears, as was already the custom among California citrus growers.



APPLES INJURED BY CODLING MOTH, SCAB, CURCULIO AND RUST

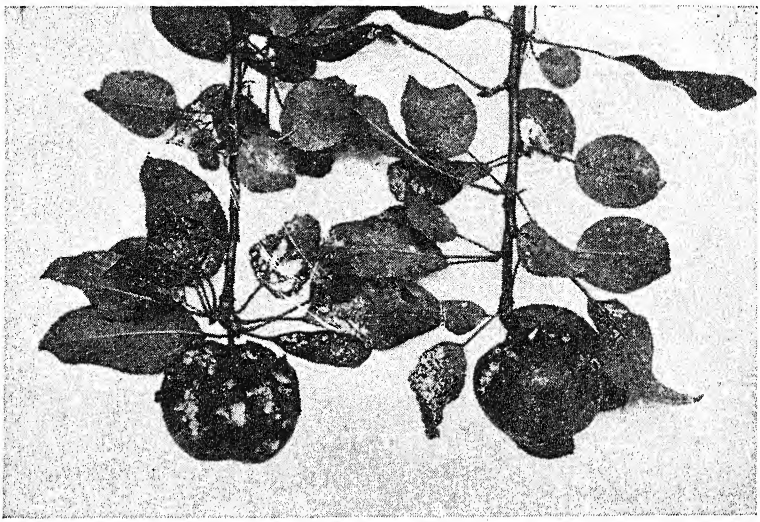
APPLE CURCULIO (*Anthonomus quadrigibbus*) is a beetle smaller than the plum curculio and of a dark brown color. It has 4 brownish humps upon the hinder portion of the body. This insect drills holes into young apples by means of its snout for purposes of feeding and also for places in which to deposit eggs. As soon as the grub hatches it burrows into the core where it feeds. Apples infested with this insect usually do not fall to the ground, and the species is therefore difficult to combat. Picking affected apples from the tree and jarring the curculio into traps, as recommended for the plum curculio, are effective against this insect.

APPLE MAGGOT (*Trypeta pomonella*) is a fly smaller than the common house fly and may be recognized by its black color, yellowish head and legs and the presence of white bands across the abdomen. The flies appear early in June and bore holes in the apples, in which they lay their eggs. The eggs hatch within a few days and the maggots feed on the pulp of the fruit, which they honeycomb completely. When the maggots become full grown they leave the apple and burrow into the ground, where they undergo their transformation, occasionally however remaining in the apples. Spraying with insecticides gives unsatisfactory results. The collection and destruction of windfalls and refuse under the trees and from bins and barrels in which fruit has been stored are more effective means of repression.

BORERS. Two species are especially injurious to apple trees and are known as the flat-headed and round-headed apple tree borers. The round-headed borer (*Saperda candida*) is a beetle about ¾ of an inch in length, of a brown color, with 2 white stripes on the back. The eggs are deposited on the bark near the ground, and on hatching the grub enters the wood. The flat-headed borer (*Chrysobothris femorata*) is smaller, of a dull color, with a metalic luster. This beetle lays its eggs on the trunk or larger branches, and the grub enters the sapwood. The grub remains in the wood 2 years, while that of the round-headed borer lives 3 years in that position. Both species may do great damage especially to young trees. Painting the trunks with whale oil soap or dilute soft soap in the spring and digging out the grubs in the fall are recommended.

TENT CATERPILLAR (*Clisiocampa Americana*) is the larva of a night-flying moth which is brown in color and about an inch

across the wings. The eggs are laid in July in clusters upon the small twigs of apples, wild cherry and other trees. They hatch in the early spring and the young caterpillars form a tent, in which the whole colony lives. They usually feed twice a day, about the middle of the forenoon and the afternoon, at which times the tents are deserted. Each caterpillar remains in connection with the tent by a fine thread, spun as it crawls. When not feeding they remain in or on the tent. A number of birds feed upon the caterpillars, and a contagious disease prevails at times during moist warm weather. The egg masses may be readily seen and collected, and the caterpillars may be destroyed in their nests by saturating with kerosene and burning. The nests should be burned in the early morning or late in the afternoon, when the caterpillars are in them.



APPLES INJURED BY JAPANESE BEETLES

Canker Worms (*Anisopteryx vernata* and *A. pometaria*). The chief difference between these species is in the time of egg-laying, the former laying them in the spring, the latter in the fall. In both species the male is of a grayish color, about an inch across the wings, while the female is about ½ inch long and wingless. The caterpillars are commonly called measuring worms on account of their mode of motion. They feed upon the leaves of apple, pear, peach, other fruit trees and the elm. The trunks of trees may be smeared with a band of tar and printers' ink mixed with oil, for the purpose of preventing the wingless females from crawling up the trunks to deposit their eggs. Another preventive treatment consists in placing inverted cones in which oil, or some similar substance, is placed about the trees. The caterpillars may be destroyed by 1 or 2 early sprayings of Paris green or arsenate of lead.

Cicada (*C. septendecim*) is also called the 17-year locust on account of the length of time which it spends in the ground in an immature stage. The insect is wedge-shaped with a broad head, of a brownish-black color, with red veins in the transparent wings. The 17-year locust is readily distinguished from the common dog-day locust by the fact that the latter is larger and has green veins in the wings, as well as a greenish body, with a white powdery covering on the underside. Some of the southern broods spend only 13 years in the immature stage, while in the north the life of the insect extends over 17 years. The adult cicada lives about a month and causes considerable damage by depositing its eggs in small twigs of the apple, oak and various other trees. The eggs are laid in a double row in a slit made in the wood, and when the insects are present in large numbers the trees are often killed by this operation. As soon as the young hatch they fall to the ground, and live for the remainder of the 13 or 17 years, according to the brood, in the ground where

they feed upon the roots of trees and herbaceous plants. There are 21 well-known broods of this insect in the United States, but the broods overlap one another so that locust years are not 13 or 17 years apart. Kerosene emulsion will destroy the cicadas when they first emerge from the ground, but no remedies can be applied after the swarm has begun flying about. Hogs root out and destroy the immature cicadas in the ground, and domestic fowls, sparrows and other birds feed upon them when they appear. Since the time of the appearance of each brood is predicted for a number of years ahead, it is recommended that no pruning be done during the fall preceding the appearance of the swarm. A number of twigs will be destroyed by the cicadas, and these may be cut off in the spring.

This list includes the more important injurious insects of the apple tree. More than 200 species of insects have been found depredating upon the apple, but the majority of these are not common, or feed chiefly upon other plants.

Pocket Gophers. These animals are recognized by their stout, compact bodies, small eyes, and strong front feet, which are armed with long curved claws. The front teeth are also very strongly developed. The pocket to which the name of this animal is due, has an external opening outside of the mouth. When feeding they rapidly gather materials together, which are stored in the pockets, and then retire to a safe retreat where their food is eaten. A number of species of pocket gophers are found in the United States, and their distribution extends from Illinois to the Pacific Coast and includes Georgia and Florida. Pocket gophers spend their lives under ground and are seldom seen. Rarely they are observed following a road or trail. These animals are especially injurious to potatoes and other root crops, and to fruit trees, of which they gnaw the roots. Bounties have been offered for these animals, but this method of extermination has not been satisfactory. The pocket gophers may be destroyed by fumigation, trapping, bisulphid of carbon or poison, as recommended for ground squirrels. Another method which has proved very satisfactory in protecting orchards against the inroads of pocket gophers consists in surrounding the orchard with a trench, walled with boards, and dug to a depth of 3 feet. The gophers in burrowing through the soil fall into the trench and are unable to escape.

APRICOT (*Prunus* spp.)

A tree and fruit somewhat intermediate between the peach and the plum. The fruit generally ripens in advance of both the peach and the plum, is somewhat peach-like in shape and color, has smoother skin, with rich yellow flesh, and a large, flat, smooth stone. The flesh is commonly less juicy than that of the peach and of good quality. The apricot is little grown commercially in the Eastern United States, but is extensively cultivated in some of the more western States, especially California. There are about 6 million apricot trees in the U.S. of which 5 million are in California. It is hardy wherever the peach is hardy, and some of the Russian varieties will stand even 1 or 2 degrees more cold than the peach. In the Eastern and Northern States only the best fruit growers succeed with the apricot. The difficulties in the way of successful culture are its habit of early blooming and consequent liability to injury from late spring frost, and the ravages of the curculio.

The apricot is grown on either peach, plum or its own roots. On suitable soils, i.e., deep, loose, rich, well-drained loams, or in California on adobe or gravelly soils, it succeeds best on its own roots. On peach soils it is generally grown on peach roots, while on heavier soils it is grown on plum roots. Most of the apricot orchards in the United States are grown on peach roots. The apricot has an aversion to heavy, cold, wet soils and will not succeed on them.

Because of the early blooming habit of the apricot great care must be taken in selecting a suitable location and exposure for the orchard. This should be high and, if possible, near a large body of water, since frosts are less serious in such localities. It is useless to plant trees on low, frosty ground. A northern or northwestern exposure is desirable because of its retarding effect on the blossoming period. On all lighter and drier soils nursery-budded peach stock is recommended. For the stiffer lands the New York Cornell Station is inclined to favor top-worked plum stock, that is plum trees top-budded or grafted in the orchard with apricot.

The proper distance for setting the trees in the orchard is about 20 feet each way. Where nursery-budded trees are used the trees should be set low, so that, if possible, the union is below the ground. This lessens the danger of the tree breaking at the union and of injury from the root borer when peach stock is used.

The orchard treatment of the apricot is in general the same as that for peaches. The apricot is about as productive as the peach, and unless heavily thinned bears only in alternate years. In the East it is largely a dessert fruit, and should, therefore, be put up in small tasty packages. In California it is one of the leading commercial fruits, and is extensively used for drying and canning.

There are 3 classes of apricots grown in the United States: the best, and the ones most largely cultivated, belong to the group *Prunus Armeniaca*. For the East, Harris and St. Ambrosie are among the best varieties for the early crop, and Moorpark, Royal, Montgamet and Turkish or Roman, for the midseason and late crop. In California Royal is a favorite, followed by Blenheim and the Peach. The hardy Russian sorts belong botanically to this same group, but, while very productive, they are smaller and of poorer quality and best suited for culture on the northern borders of the peach belt. The better varieties are Alexander, Gibb, Alexis and Catherine. The black or purple apricots form another botanical class, *Prunus dasycarpa*. The fruit is of a dull purple color, unattractive and sour, and clings rather persistently to the fuzzy pit. The Chinese or Japanese apricots belong to *P. mume*, and are chiefly grown for their ornamental blossoms, which vary from purple to dark red in color, and from single to very double.

There are a number of diseases and insects which attack the apricot. The most serious fungous disease is the collar rot. This is destructive to the trunk. The disease begins just below the surface of the ground, where the bud is inserted, and affects the bark for a distance of a few inches above the union. Later the trunk may become discolored and the branches appear stunted. The cause of the trouble is not well understood, but it is suggested that the disease may be due to unfavorable soil and climate and imperfect union. For other fungus diseases *see* under *Plum* and *Peach*.

One of the most serious hindrances to the successful culture of the apricot is the plum curculio, for the treatment of which *see* under *Plum*.

AVOCADO (*Persea americana*)

Avocado is a tree indigenous to tropical America which has become universally distributed through the tropical and subtropical countries. The tree attains a height of 20 to 60 feet. The leaves are large and glossy. The fruit may be oblong, pear shaped, nearly spherical or bottle shaped, may vary in length from 5 to 12 inches, in weight from 1 to 4 pounds and in color from green through browns to purple. The rind varies from almost the thinness of paper to a thick woody shell.

There are about a million bearing avocado trees in California and Florida, besides being an important local fruit crop in Hawaii, Porto Rico, Panama Canal Zone and Virgin Islands. Plantings have also been made in southern Texas. Production of avocados in the U.S. has reached nearly 35 million pounds yearly. The accidental introduction of the fruit fly into Hawaii put a quarantine on avocados from there, but it was soon found that adequate cold storage rendered shipments safe. Varieties of the Mexican type are used almost exclusively in California, particularly the Fuerte. In Dade County, Florida, Fuchsia, Trapp and Waldin are favorite varieties. Several varieties are usually planted in each grove in order to insure better pollination.

The avocado is commonly propagated by inserting tip cions as cleft or side grafts on young seedlings grown from seeds planted in boxes the previous fall. The planting distances in the orchard are 20 to 30 feet apart both ways. In Florida pigeon peas, crotalaria or velvet beans are grown in the orchard and cut from time to time for mulching the trees. Avocados are heavy feeders. Bearing trees require about 30 pounds yearly of a 4-8-6 standard fertilizer. The yield of fruit varies within wide limits, but about 80 pounds a season per tree is a reasonable expectation.

BIRDS

An extensive popular literature has grown up during recent years around the subject of birds as related to agriculture. In various States laws have been framed restricting the time in which game birds may be destroyed and prohibiting the killing of a number of species of birds which are considered beneficial to agriculture. The question of the economic importance of birds has awakened widespread interest and a great deal of work has been done in the study of the feeding habits of birds, especially by the United States Department of Agriculture and at some of the experiment stations. As a rule these investigations show that the diet of birds consists to a considerable extent of injurious insects. The varia-

tions in the number of injurious insects in different years are striking, and are due to a number of conditions to which attention has been called by different writers. An exact estimation of the value of birds in this connection can hardly be made at present. The statement can be made concerning any particular bird that its food normally consists of certain percentages of injurious insects, beneficial insects, injurious weed seed, cultivated fruits, etc., and from this general statement a conclusion can be drawn as to whether the bird is on the whole beneficial or injurious to agriculture. In the case of many species great differences of opinion prevail among practical men on account of the great variety of food materials eaten by the birds according to local conditions. Hawks and owls in some localities are considered very injurious and bounties have been offered for their destruction on account of their depredations upon poultry yards. At the same time it should be remembered that these birds at other times of the year and in other localities destroy many injurious rodents, such as field mice, ground squirrels, gophers and rabbits.

The feeding habits of the robin were investigated at the Ohio Experiment Station and it was concluded from this study that during the fruit season in the neighborhood of small fruit gardens these birds did more harm than good from their destruction of such a large quantity of fruit. A study of the feeding habits of the same bird in other localities at other times of the year gave the robin credit for destroying a large percentage of injurious insects. The English sparrow may be cited as another example of a bird of doubtful economic relations. In the vicinity of grain fields, when occurring in great numbers, the English sparrow is undoubtedly a pest. This bird, however, is an enemy of the 17-year locust and dog-day locust and destroys great numbers of them. It is also known to feed upon other injurious insects.

Few birds of which the feeding habits have been studied have been found an unmixed good or evil, and the attitude of many practical farmers and gardeners toward this problem involves a feeling of the right to protect crops or poultry against the attacks of birds, and at the same time a disinclination to persecute or needlessly destroy these birds under forest conditions or in localities where they are not injurious to cultivated crops. During the winter season it is undoubtedly true that many species of birds destroy large numbers of injurious insects in the egg or pupal stage, and in so doing more than repay for any damage they may commit upon crops during the growing season. In general, birds do far more good than harm, and the ruthless destruction of birds without special reasons should be discountenanced by everybody.

BLACKBERRY (*Rubus villosus*)

The cultivated blackberry is gradually superseding the wild crop which has long been a serious rival on account of the wide distribution of the wild species and its habit of growing in fence rows and waste places readily accessible to large numbers of berry eaters. The blackberry is a shallow rooted plant and in dry seasons the wild berries dry up and become unpalatable. The cultivated berries span a longer season, coming upon the market earlier and holding their position longer. The chief cultivated blackberry belt extends from Texas northeast to Maine, totaling about 27,000 acres in which Texas has the largest plantings followed by Oklahoma, Missouri, Arkansas, Kentucky, West Virginia, Michigan and New Jersey. There are also extensive developments in the Puyallup district of Washington and in the Willamette Valley of Oregon.

Blackberries thrive on a great variety of soil types but satisfactory yields cannot be obtained unless an adequate supply of moisture is present during the growth and ripening of the fruit.

Cultivated blackberries are coming more and more into use. Usually they sell the best of any of the small fruits. The yield averages 100 bushels per acre. They are used in the fresh state and for canning, but are seldom dried. Experiments at the New York Cornell Station show that from a bushel of blackberries not more than 12 or 14 pounds of dried fruit can be obtained. Berries sprinkled with granulated sugar dry better than those not treated.

A deep clay loam supplied with humus is the best land for blackberries. Sandy or gravelly soils dry out too easily at the critical period when the fruit is ripening. Blackberry plants should be set out in the spring. Suckers are usually used for this purpose. Plants are set 2 or 3 feet apart in rows 8 feet distant. Crops like potatoes or strawberries may be grown between the rows the first 2 years to pay for the use of the land. If the plants put out vigorously the first year, 3 or 4 canes may be allowed to grow. These should

be headed back when they have reached a height of 2 or 3 feet by pinching off the tops.

The blackberry fruit is grown on canes which came from the roots the preceding season. After the fruiting season is over the usefulness of these canes or shoots is at an end and they should be cut out of the rows. This is performed preferably in the fall, but may be done any time before growth starts in the spring. While fruit is being produced on some canes, others are coming up from the roots. Usually only 5 or 6 canes from each root should be allowed to grow, the others being pulled out while they are still small. When canes are 2½ to 3 feet high the tips should be cut or pinched back 2 or 3 inches. This stops upward growth and many laterals push out. These laterals bear the fruit the following season. They should be shortened somewhat in the spring, depending on the variety grown. Blackberries thus trained require no trellising. In bleak situations blackberries in the more northern sections will require winter protection. This is best done by laying the vines over and covering with earth 2 or 3 inches deep. Sometimes a trench is dug on one side of the rows 6 or 8 inches deep to facilitate laying down. Care should be taken not to crack the canes. In the spring, when danger from frost is past, the vines are righted. The blackberry patch should be plowed in the spring and given thorough shallow cultivation about once a week up to within a day or two of the time of picking. Well-rotted stable manure is the best fertilizer for blackberries.

Blackberries produce a fair crop the first year of planting. The third year a full crop is probable, after which nearly uniform crops should be secured. A good plantation well cared for should last 20 years or more without renewing. The yields vary from 40 to 300 bushels per acre, depending upon the intelligence put into the business. Investigations at the Georgia Station showed that plats of blackberries over 6 years old gave decreased yields of from 58.9 per cent with Agawam to 25.6 per cent with Ancient Briton, as compared with plats of similar varieties only 2 years old. It is believed that in Georgia the blackberries should be renewed every 4 or 5 years.

Barnyard manure is probably the best fertilizer, about 20 tons per acre, annually, or leguminous cover crops may be planted between the rows.

In the Northern and Northeastern States Eldorado is far in the lead of varieties. In the Southwest several kinds have become adapted to a semiarid climate. Among them are Dallas, Crandall and Early Wonder. The varieties most grown on the Pacific Coast are Eldorado, Lawton, Evergreen and Himalaya, the canes of the last named apparently being perennial. For the most part blackberries are self-fertile and need not be planted with special reference to cross fertilization.

Enemies: CROWN GALL (*see* under *Apple*) and RUST are perhaps the most serious diseases of blackberries. Canes affected with those troubles should be dug up and burned.

BLUEBERRY (*Vaccinium* spp.)

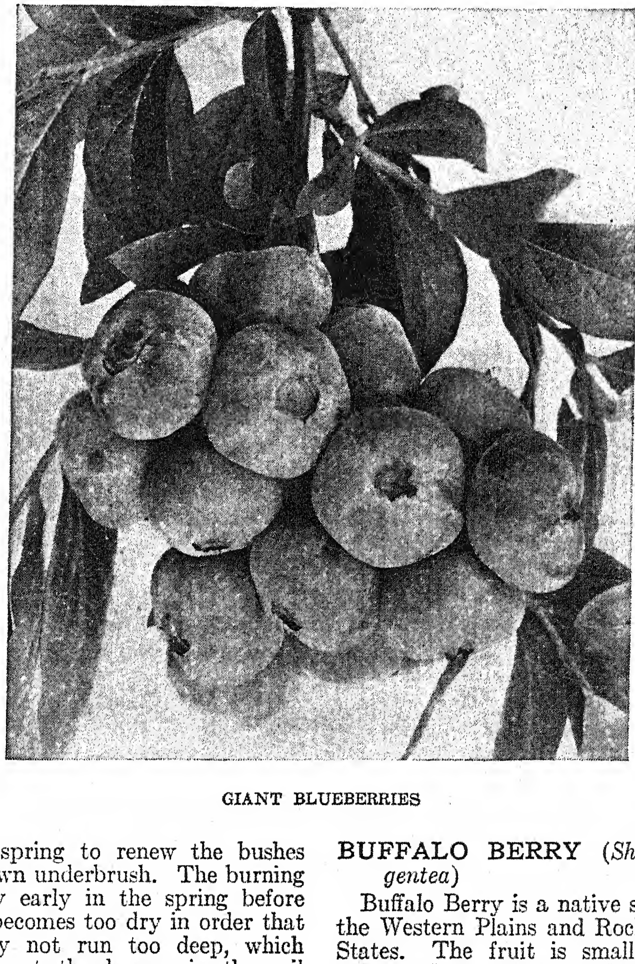
Several species of wild blueberry are gathered and marketed in the regions where they occur. Their importance is constantly increasing. The chief blueberry belts are three. One extends from Maine along the coast to Louisiana. A second runs from Maine westward to Minnesota. A third stretches along the Pacific Coast from British Columbia to central California. Besides these there are isolated areas of importance in Arkansas and the interior of Washington, Oregon and Idaho.

The low bush berry is indigenous to the northeastern portion of the U.S. and parts of Canada. It is an upland species. The highbush blueberry is common in moist woods and swamps from southern Maine to Michigan and south to Georgia. Other wild forms of economic importance are the dryland blueberry, ranging from Oklahoma to Maryland, and the evergreen blueberry along the Pacific coast.

According to George M. Darrow, at least 12 varieties of cultivated highbush blueberries are grown commercially from North Carolina to New England, New York, and Michigan and also in Oregon and Washington. This development followed upon the long-continued research of Dr. F. V. Coville on the soil conditions necessary to the successful raising of highbush blueberries. In ordinary rich garden soil it was found that this plant would not thrive and would soon die. "Cultivated plantings have succeeded on acid soils having ample moisture. The best indication that blueberries will succeed on a soil is that they, or some of their relatives, such as huckleberries, azaleas or laurel are found growing on the soil."

In many of the Eastern and Northern States extensive blueberry barrens occur

on lands which are, as a rule, too poor for other agricultural purposes. The blueberry bushes on these barrens are low, scarce exceeding a foot in height, and frequently bear heavy and profitable crops. A systematic treatment of these barrens has been reported by the Maine Station. The barrens reported upon cover an area of 40,000 acres and belong to one owner. About ⅓ of the barrens is burned over every spring to renew the bushes and keep down underbrush. The burning is done very early in the spring before the ground becomes too dry in order that the fire may not run too deep, which would burn out the humus in the soil and ruin the barrens. The fire is spread by having a workman pass around the area to be burned dragging after him an ordinary torch. This is the only care given. The first fruits to ripen are picked by hand and sent to the city markets usually in quart boxes. Later in the season the fruit is sent to the canneries. On the older barrens, especially on areas to be burned over the following spring, the fruit is gathered with a blueberry rake. This is a rake made something like a dustpan, the bottom of which is composed of stiff parallel wire rods. The fruit is gathered quickly and cheaply by means of this rake, but the bushes are seriously injured by the treatment, and it should, therefore, never be used with highbush blueberries.



GIANT BLUEBERRIES

BUFFALO BERRY (*Shepherdia argentea*)

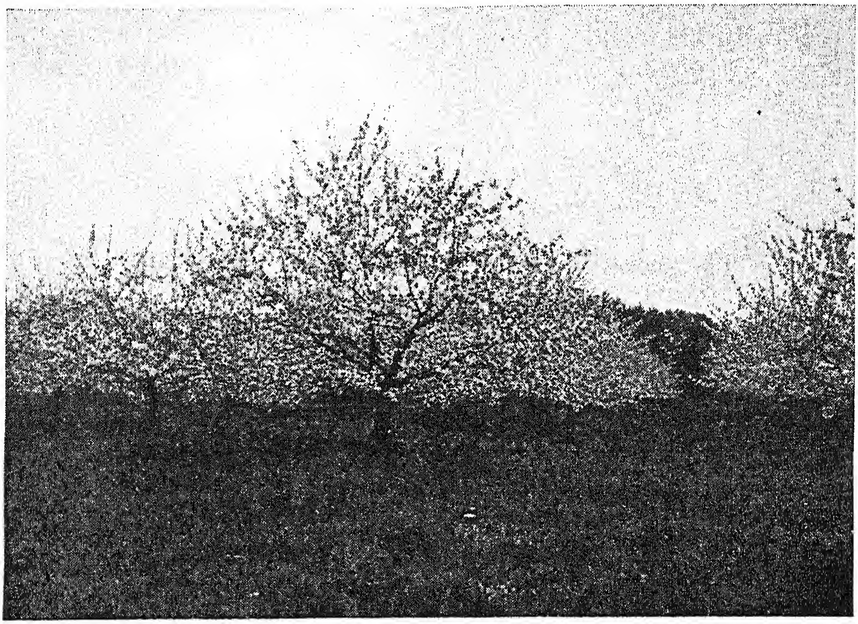
Buffalo Berry is a native shrub fruit of the Western Plains and Rocky Mountain States. The fruit is small, quite acid, either red or yellow, and has small seeds. It is not considered of importance where currants will grow, but has a value in the drier portions of the Northwest where the culture of the better bush fruits is precarious. The plant is propagated either by seed, cuttings or suckers. The male and female flowers are borne on separate plants. This necessitates care in transplanting to see that both kinds of plants

are set as otherwise no fruit will be obtained. The plant is quite ornamental and is sometimes recommended as a hedge plant for the Northwest.

CHERRIES

The three main groups of cultivated cherries are the sour (*Prunus cerasus*), the sweet (*Prunus avium*) and the Duke group. As compared with other deciduous fruit trees the cherry crop is made up of a very few varieties. East of the Rockies the Richmond, Montmorency and Morello are the most important sorts, while the leading sweet varieties are Tartarian, Windsor, Napoleon and Spanish. Sweet cherries are less tolerant of cold than are the sour sorts. Cherries are grown in every State, but the bulk of the commercial crop comes from 12 States. Washington, California and Oregon lead in the production of sweet cherries, followed by Michigan, Utah, Pennsylvania and New York. Michigan, Wisconsin and New York are the largest shippers of sour cherries, the total U.S. crop of both kinds being 163,000 tons.

The same considerations apply in choosing the site of a cherry orchard as for peach or apple, with the added requirement of quick transportation since cherries are highly perishable. Sandy or light loams are the prevailing soils in the cherry centers around the Great Lakes. Sweet cherries bloom slightly earlier than the sour kinds. But all cherries are susceptible to frost and proper air drainage should always be a consideration in locating the orchard. Cherries are propagated by budding or grafting on hardy seedlings, usually the mahaleb or mazzard or occasionally the wild pin cherry. But the ordinary grower has found it to his advantage to buy budded 1 or 2-year old trees from reputable nurserymen. Early spring planting is advisable, making sure that the buds are dormant. For sour cherries 20 by 20 feet is the standard distance for planting in the orchard. Sweet sorts are given more room, about 25 feet both ways. Pruning aims to make the young trees head out at a point not higher than 2 feet from the ground.



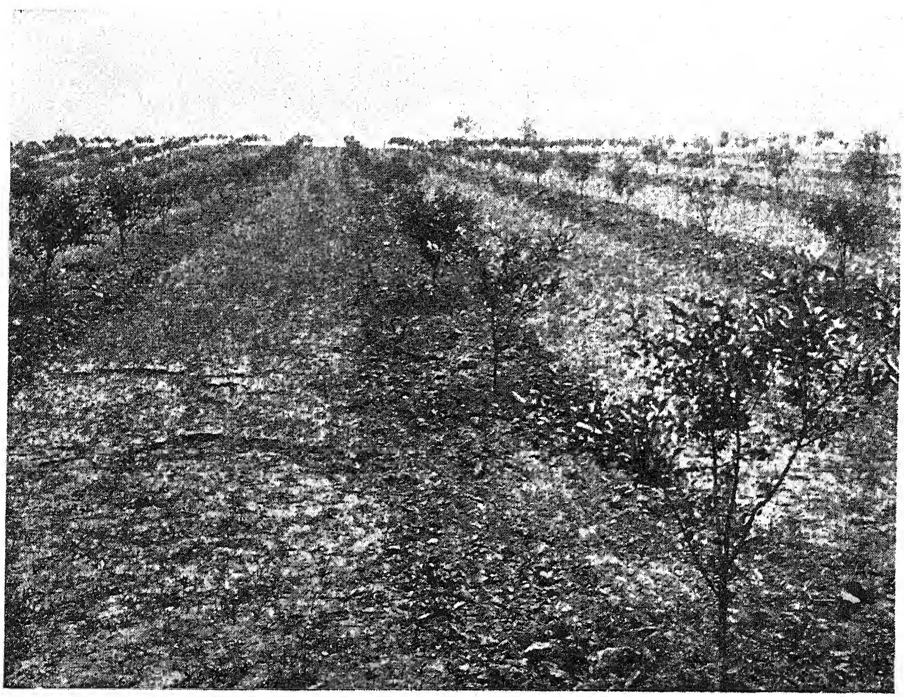
CHERRY TREES IN BLOOM

Tillage for cherry trees should be the same as for the peach. Cover crops are usually sown at the last cultivation, the choice commonly falling on vetch and clover for legumes, and on rye, rape or buckwheat for non-leguminous cover crops. Manure is a standard fertilizer for cherries, supplemented with commercial brands sparingly. Peas, beans, tomatoes or other vegetables may be grown as intercrops till the cherries come into bear-

ing. In Colorado the application of a nitrogen fertilizer consistantly increased the yield. Careful attention to irrigation in semiarid regions is necessary. If the supply of water is somewhat scant the most essential application is shortly before the fruit reaches maturity.

Russian Varieties. In some of the more northern regions and in regions subject to late spring frosts some Russian varieties of cherries have proved successful where common sorts fail. These cherries possess a dwarf, compact habit of growth and blossom and ripen their fruit later than common sorts.

Other Sorts. A few other cherries may be briefly noted. The Western dwarf cherry (*P. Besseyi*) found upon the plains beyond the Mississippi and extending into the mountains of Colorado and Utah, is considered a fruit of great promise for cultivation. Improved Dwarf Rocky Mountain cherry is a variety of this species which promises much as a parent of a new type of cherries which from their very dwarf habit will be adapted to small gardens. The Wild Black cherry (*P. serotina*) is a valuable ornamental and forest tree in many States. It has made very satisfactory growth at the Minnesota and South Dakota Experiment Stations. The chokecherry (*P. Virginiana*) is a small shrub with very astringent fruit and valuable only from an ornamental point of view. The Western chokecherry (*P. demissa*) is a shrubby plant which produces fruit having an agreeable taste closely resembling that of black cherry. These are free from astringency and are frequently used by settlers for jelly, pastry, etc.



YOUNG CHERRY ORCHARD IN TENNESSEE

Enemies: Brown Rot. *See* under *Peach.*

Leaf Curl (*Exoascus pruni*) causes the formation of dense tufts of twigs from a single point. No fruit is borne on these so-called witches' brooms and the leaves are yellow or red. Affected parts should be cut off and burned.

Curculio. *See* under *Plum.*

Slug (*Selandria cerasi*) in the adult condition is a black 4-winged fly, which lays its eggs in the leaves. The larvae, which become full grown in about 4 weeks, are of a shiny dark green color and eat the leaves except the large veins. Dusting the trees with hellebore, pyre-

thrum or air-slaked lime or spraying with the arsenites will destroy these insects.

CHERRY FRUIT FLY (*Rhagoletis cingulata*) is a 2-winged fly with a black body and 4 black bands on each wing. The maggots are light yellow and have a fan-shaped organ near the head. The maggots mine through the pulp of the cherry and their presence is not always detected at picking time. Domestic poultry in the orchard will destroy many of the maggots, and since the insect passes a long time in the soil it could be destroyed to some extent by thorough cultivation in the fall.

CHESTNUT

The native American sweet chestnut, the majestic forest tree which once ranged from Maine to Michigan and south to Georgia, is practically extinct. The blight (*Endothia parasitica*), accidentally introduced from Japan, has done its work and only an occasional tree out of the vast heritage remains alive. The disease reached Illinois in 1925. Breeders are industriously working on the problem of securing immune varieties.

Chestnuts are propagated by grafting or budding. At the present time propagation is mostly confined to hybrids obtained by crossing the American chestnut or chinkapin, with the European or Asiatic species. The chinkapin has proved quite satisfactory as a dwarf stock.

The Chinese, and other Oriental chestnuts now grown in the U.S., present some varieties which give promise of a chestnut industry, although Asiatic chestnuts often show a low percentage of survival after planting.

Following the destruction of chestnut groves by the blight, experiments were made in the utilization of the dead trees. It was found that 70 or 80 per cent of the heartwood of trees that had been dead for 25 years was still good for lumber. The tannin content had not deteriorated, but the bark and sapwood were beyond use.

Propagation. Chestnuts are propagated from seed planted either in the fall or spring and the seedling trees later grafted or budded with improved varieties. Nuts intended for seed must not be allowed to dry out or they will not germinate. When kept over winter for spring planting they should be preserved in a box buried 6 inches deep in the open ground and alternating in single layers with moist sand. The trees have a long tap root which makes them somewhat difficult to transplant, therefore, when possible, it is advisable to plant the nuts where the trees are to stand. In the nursery the trees are grown in rows 4 feet apart, 18 inches distant in the row. When 2 years old they are grafted. The Connecticut Experiment Station found that the best time for grafting chestnuts in that latitude was between May 15 and June 15. At that station whip grafts made the best unions on small stocks and cleft grafts on large stock. Either root, crown or stem grafting may be practiced, and each method has its advocates. The chestnut graft is somewhat difficult to make and the technique of the work must be carefully done. Under favorable conditions 50 per cent of the cions set may be expected to grow.

The following fall or spring, after the trees have been grafted in the nursery row, the trees may be transplanted to their permanent places in the orchard, the European varieties 40 feet and the Japanese 30 feet apart each way. The tap root should be cut back to 18 inches and the tree pruned to an open, spreading form, with 3 to 5 main branches. Cultivation should be practiced similar to that given a young apple orchard.

Grafted chestnut trees grow rapidly and Japanese varieties frequently set fruit the first year of the insertion of the cion, and both Japanese and European varieties frequently bear heavy loads of burs the second year. Good growers find it advisable to pick off all burs for the first 3 or 4 years in order to give the trees opportunity to become well established and vigorous before the strain of reproduction begins.

Enemies: LEAF SPOT (*Septoria ochroleuca*) attacks young trees in the nursery and also old trees. It appears as numerous bright spots on the leaves, which later turn brown. The disease may be controlled by spraying with Bordeaux mixture. Chestnuts are subject to the attacks of an anthracnose which is seldom serious.

The chief insect injuries to chestnuts are due to 2 weevils (*Balaninus proboscideus* and *B. rectus*). Both weevils have long snouts. The first species is the larger and bears yellow lines and spots on the thorax. The general color of the second species is light brown. The adults of both weevils appear about the blossoming time of the chestnuts and deposit their eggs, which hatch into the well-known grubs that live in the nuts. The second species also infests chinkapins and acorns. All infested nuts should be destroyed be-

fore the grubs have opportunity to escape to the ground, or they may be fumigated with carbon bisulphid (1 pound to 1000 cubic feet of space).

Chinkapin (*Castanea pumila*). This is a dwarf chestnut. It grows wild on sandy knolls and hillsides from Florida north to Delaware, west to Indiana and southwest to Eastern Texas. It is a spreading shrub or small tree, sometimes attaining 20 to 30 feet in height, though the shrub is more usual. The nuts are borne singly in chestnut-like burs. They are smaller than chestnuts, are produced more abundantly and ripen considerably earlier, and for this reason reach the market first and sometimes bring higher prices than chestnuts.

The Western chinkapin (*C. crysophylla*) is found in the Cascade, Sierra Nevada and Coast Range mountains below 4000 feet elevation, and in Oregon. In some counties of California it forms a large tree 50 to 125 feet high and 2 to 3 feet in diameter. The more abundant form, however, is a small shrub 2 to 6 feet high. So far as known there is only one improved variety of chinkapins under cultivation.

CITRUS FRUITS

Citrus fruits, while grown only in the southern and southwestern fringe of the country, are to be had the year round on the markets of every State. Practically all our citrus fruit is raised in California, Florida, Texas and Arizona, about half the oranges in California and the other half in Florida, Texas, Louisiana, Arizona and Mississippi; half the grapefruit in Florida and the rest in Texas, Arizona and California; nearly all the lemons in California, with perhaps 1 per cent in Florida, while Florida stands practically alone in the production of limes. From a total of 53½ million trees come 135 million boxes of oranges, grapefruit, lemons and limes to be distributed as food and drink, fresh, canned or carbonated.

While citrus fruits are grown in all parts of Florida, the freezes of 1835, 1886, 1894, 1899 and 1917 have forced production on a large scale into the southern half of the State along the Atlantic and Gulf Coasts. Grove sites are chosen on land higher than the surrounding country. Even a slight elevation may make a difference of 5 degrees in temperature on cold nights in favor of the higher land. Good soil drainage is also imperative. The water table should never be nearer than 4 feet from the surface at any time of year. Nearness to large bodies of water is another important point in frost protection. Windbreaks lessen the drying effect upon the foliage from winter winds.

In Florida the hammock soils are richest in plant food and humus and are excellent for citrus plantings. The high pine lands with sandy loam soil, underlain with a clay subsoil at a depth of about 6 feet, have served well for the newer groves.

Ranked in order of their importance in Florida, the round orange comes first, followed by grapefruit, Satsuma orange, lemons, limes and kumquat, while citron and shaddock are occasionally grown chiefly as ornamentals. During the past 40 years the canning of grapefruit hearts has developed into an important branch of the citrus industry, amounting to over half a million cases. Grapefruit juice also has a promising future. The standard varieties of oranges recommended by the growers are Parson, Homosassa, Valencia, Pineapple, and Lue. Many other varieties are grown to a less extent.

As reported by E. D. Vosbury, orange trees for planting in Florida are commonly budded on sour orange, rough lemon or less often on other stocks. Planting is usually done from December 15 to February 15, from 25 to 30 feet apart both ways.

The citrus producing area of California extends from the Mexican border to Tehama Co., a distance of 650 miles, the northern rim of the citrus belt being at the same latitude as New York City. The mountain ranges fend off the cold winds from the north while admitting warm southwesterly winds from the Pacific. The rapid growth of the citrus industry in California is due partly to excellent transportation facilities to all parts of the country, partly to the early organization of the unusually aggressive and efficient California Fruit Growers Exchange, and also to the fact that the Washington Navel orange, planted first at Riverside in 1873, was found to be peculiarly adapted to California climate, and soon acquired an outstanding vogue among orange consumers. About 85 per cent of the citrus fruit raised in California and Arizona is controlled by cooperative associations. The California Fruit Growers Exchange handles 72 per cent of the oranges, 67 per cent of the grapefruit and 90 per cent of the lemons.

In the lower Rio Grande Valley of Texas the popular demand is centered on Ruby and Marsh grapefruit, Hamlin and

Valencia oranges, Clementine tangerine, Meyer and Eureka lemons and the Mexican lime. In variety tests with grapefruit over a series of years the yield per tree ranged from 320 to 850 pounds for the different varieties.

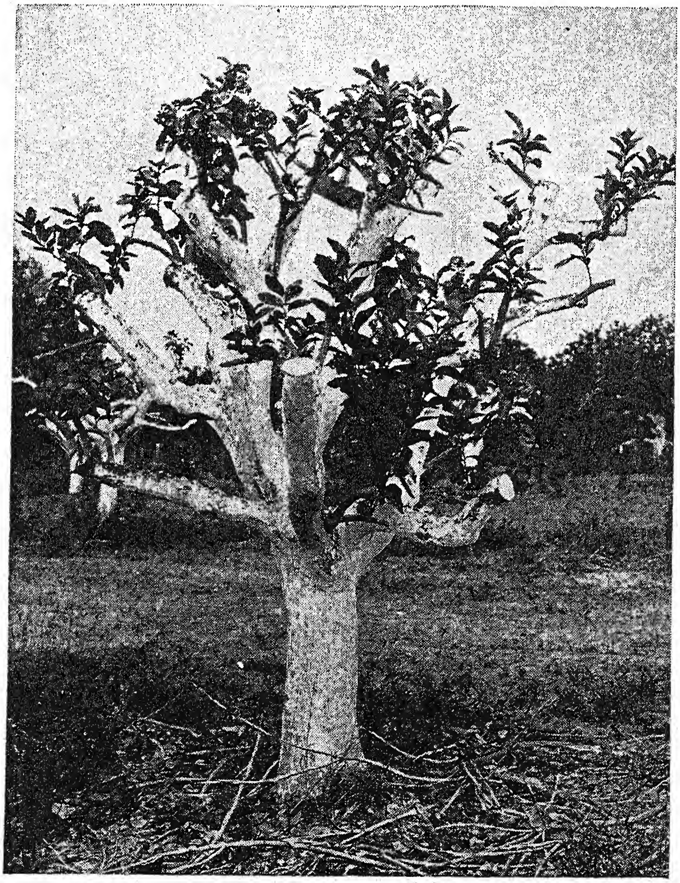
Florida growers apply fertilizer to young citrus orchards 3 or 4 times a year, in early spring, midsummer and early September, the first two applications being complete fertilizer, reducing the amount of nitrogen in the fall dosage. The total amount per tree the first year is 1 or 2 pounds, increasing a pound a year for 5 or 6 years. Bearing trees from 10 years of age upward receive from 15 to 75 pounds according to size of trees and soil conditions.

In hardiness or frost tolerance citrus fruits stand in the order: oranges, grapefruit, lemons, and limes. The lime industry in Florida is of recent development. About 85 per cent of the plantings have been made since 1933. Interest has centered somewhat on the Persian lime which has been budded on 5 or more sorts of root stocks. Limes grown on rough lemon stocks were of greatest weight and size.

Florida citrus growers maintain clean cultivation around the trees, but often plant crops between the rows while the trees are young. In this system lettuce, beans or cabbages may be chosen, or peach trees may bear 3 or 4 crops of fruit before they interfere with the citrus and must be removed.

Enemies: In Florida the most important diseases of citrus fruits are foot rot, or gum disease, die back and sooty mold. In California the worst troubles are gum disease, scaly bark, die back and orange and lemon rot.

Foot Rot or Gum Disease attacks the



TOP WORKED GRAPEFRUIT TREE

crown and main roots. It is first recognized by an exudation of gum with a foul odor. Later the bark over the diseased area dries up. The tree continues to bear fruit, but is unthrifty, and the leaves turn yellow. Pasturing, deep setting, poor drainage, overirrigation and excessive use of manure are conditions favorable to the development of the disease. Affected parts should be cut out and burned. The cut surface should then be painted with 1 part crude carbolic acid in 4 parts of water, or with some other antiseptic solution. Sour orange and rough lemon are quite resistant, while sweet orange is very susceptible.

Scaly Bark is a form of gum disease which prevails in Southern California. It attacks the trunk and some of the branches. The disease penetrates to the center of the trunk and soon kills the tree. The sour orange and pomelo are also resistant to this disease. The same treatment should be adopted as for foot rot.

Sooty Mold appears on the leaves, fruit and twigs as a black, velvety coating. The mold is easily rubbed off. The fungus is not parasitic, but lives upon the honeydew which is secreted by plant lice and scale insects. The mold interferes seriously with the growth of the tree by shutting out the light. Spraying with resin wash is effective. Three applications should be made between December and March. The insects will thus be killed and the mold will find no honeydew on which to grow.

Die Back may be known by the twigs turning yellow, the leaves falling off and the new growth dying back to the old wood, on which brown eruptions appear. Later the old wood also dies. Underlying hardpan, impervious clay or overirrigation are predisposing causes of this trouble. These conditions produce faulty nutrition in the plant. Withholding organic fertilizers and attention to drainage have a tendency to prevent the disease.

Orange and Lemon Rot causes a softening and discoloration of the fruit with the development of a disagreeable flavor. The disease may appear in the orchard, but the fruit usually becomes affected after picking. Navel oranges are subject to this rot in the orchard. The disease may be largely prevented by cold storage, good ventilation of storehouses, wrapping the fruit with tissue paper and destruction of all rotten fruit.

The most important insect pests of citrus fruits are bark lice, especially purple scale, Florida red scale, California red scale, white scale, chaff scale, orange scale, San Jose scale, etc.

Rust Mite (*Phytoptus oleivorus*) is a 4-legged mite of minute size, which punctures the oil cells of oranges, causing a discoloration of a rusty red appearance, which is due to an exudation and drying of the oil upon the surface of the orange. In warm weather the eggs, which are laid in clusters on the surface of the leaves, hatch in 4 or 5 days. When food becomes scarce the mites migrate and travel for considerable distances. Since the mites are not protected by any covering of plant substance, they may be readily destroyed by spraying with contact insecticides.

Orange Sawyer (*Elaphidion inerme*) is a dark brown beetle with long antennae. The grubs are white, with rudimentary legs, and when full grown are about 1 inch in length. They burrow in the branches of orange trees. Usually this insect feeds by preference on dead branches of the orange, hickory and other trees. The grubs may be destroyed by pruning off and burning infested branches or by the use of a wire which may be forced into the burrows.

White Ants (*Termes flavipes*) are whitish, soft-bodied insects, resembling ants and living in large colonies. They usually feed on dead wood and decaying vegetable substances, but occasionally attack living plants, especially the parts which are below the surface of the ground. On orange trees the first attack is made near the ground and is to be recognized by an exudation of sap from the wounded bark. Extensive mulching and the use of decayed wood as a fertilizer in orange groves furnish favorable conditions for the development of these insects. White ants cannot endure exposure to sunlight and therefore the earth should be removed from the base of affected trees. Hot water, kerosene emulsion or bisulphid of carbon may be used for destroying colonies in the manner recommended for ordinary ants.

Citrus fruits are also subject to attacks of plant lice, leaf-eating caterpillars, thrips and various species of leaf bugs, besides a number of other insects of less importance.

COFFEE

Coffee stands at the head of the list of beverages. Under normal conditions the U.S. imports about 2½ million pounds annually, chiefly from Brazil and other

Latin American countries. Coffee extends about 25 degrees north and south of the equator and from sea level to an altitude of 6000. The coffee tree begins bearing at the age of 2 to 5 years, but is not considered in full production till 7 to 10 years old. The yield varies greatly in different countries and in different localities, from 500 to 1200 pounds of dry coffee per acre, or about 1 to 2 pounds per tree.

Frequent experiments with coffee have been carried on in California, Texas and Florida for the past 60 years or more. There are bearing coffee trees in Rio Grande, Texas and elsewhere in that locality. Coffee prefers soil containing a high percentage of iron and other properties such as characterize the lateritic soils of Sabine, Nacogdoches and San Augustine Counties, Texas. Shortage of the national morning beverage due to transportation troubles in war time inevitably turns attention to the possibilities of developing a domestic source of coffee. There are no more serious frosts in southern Texas than in the famous San Paulo coffee region of Brazil.

CRANBERRY

Cranberry is another specialized crop limited to a few localities where are found the soil conditions suitable to its growth. On Cape Cod, Massachusetts, the pine barrens of New Jersey, parts of Wisconsin, near the mouth of the Columbia River and a few spots in Maine, New Hampshire, Rhode Island, Virginia, Michigan and Minnesota the right environment is furnished for cranberries. The annual production in the U.S. is about 743,000 barrels grown on 28,000 acres.

As stated by G. M. Darrow, an acid peat soil is one of the necessary conditions in the site for a cranberry planting. Drainage must be provided so that the water table can be held at least 18 inches below the surface at the lowest point in the field. Sufficient water supply must be available to flood the field in winter as well as for occasional irrigation during the season to combat insects or prevent frosts. The land must be level. A conveniently located supply of sand free from loam or clay is also a desideratum. Ordinarily the wild cranberry grows on peat and sand in bogs that become flooded in winter. This gives the hint to be followed in choosing the site for the cranberry field.

Cranberry bogs are prepared by first clearing away all trees, moss and roots. The wild moss and grass growth is removed either by turfing the soil, that is, cutting the moss, roots, etc., into small squares and removing the whole down to the clean muck, or by flooding for a year or two and drowning out the wild growth. The former is the more costly, but much the more satisfactory way. The bog is then ditched to carry off the surface water. One or more main open ditches run through the central portion of the bog and laterals drained into these. The ditches are made 2 to 4 feet deep, and if water stands in them to within a foot of the surface better results are expected. The lower end of the main ditch is arranged so that it can be closed by a dam which will back up the water and flood the bog in winter. It is desirable that the bogs be covered with water a foot deep or more from December to April or May. This protects the plants from heaving during the winter and helps drown out insects. The bog is frequently flooded to avoid early spring and late fall frosts, as a protection from fire and in times of drouth. Where sufficient water is not available from the streams or ditches running through the bog it is desirable that a reservoir be constructed above the bog and kept filled with water for flooding purposes.

In some localities cranberry vine cuttings 6 to 8 inches long as planted directly on the muck bed, but the usual method of Cape Cod and Wisconsin growers is first to cover the entire muck surface about 4 inches deep with clean sand. The vine cuttings are then thrust down obliquely through the sand into the muck in rows about 14 inches apart each way. This sand layer keeps down weeds, makes a mulch for the retention of the moisture of the muck beneath, prevents a too rank growth of the vine, to the detriment of fruit production, and makes the bog easier to work in wet weather. In Wisconsin this sand is drawn on the bog in winter when the bog is covered with water and frozen over. About every 4 or 5 years a further sanding ½ to 1 inch deep is required. Sometimes vines for planting are run through a hay cutter, sown by hand like wheat and rolled in. The vines should not be allowed to dry out or they will be worthless for planting. A well-cultivated cranberry bog will yield from 100 to 300 bushels per acre annually.

The crop is gathered by hand, various devices like hand-scoop rakes, etc., having been invented for facilitating this work. When frost threatens during the picking

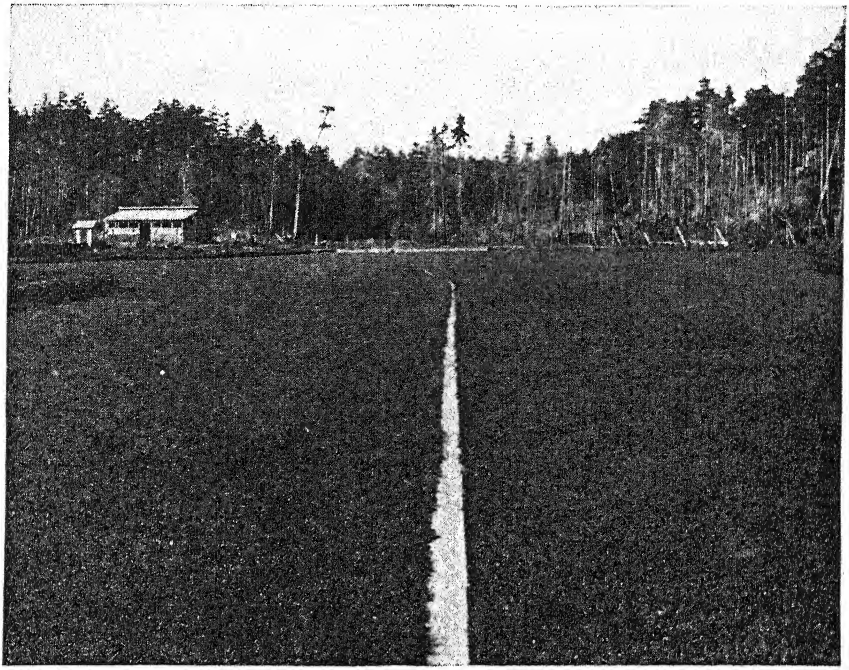
season the bog is flooded at night and the water drawn off in the morning.

According to Darrow: "During the first year of growth, a hoe can be used in weeding. After that, however, if the vines have grown well, the weeds must be pulled or grubbed by hand.

"Besides sanding, one of the most practical ways of reducing the cost of weeding in Wisconsin and in other sections, except on rich peat bottoms, is to plant a large quantity of cuttings per acre to get the ground covered quickly. Fertilizers inducing a rapid growth of vines are sometimes helpful in the same way. Weeds should be smothered out or given no opportunity to grow.

"To control weeds many growers hold the winter flood over the vines till the middle of June or even into July for a season or two before the first crop is expected. This late flooding drowns out some kinds of weeds and need not greatly injure the cranberry plants. Several kinds of weeds, including redroot, are not killed by this treatment, though many other serious ones are destroyed. If such late flooding is practiced in Massachusetts the water should not be more than a foot deep over the vines, for deep late flooding in that section is usually very harmful to them. Moreover this is a rather questionable practice for Massachusetts and New Jersey, because it subjects the fields to army-worm and cutworm incursions after the water is let off."

Enemies: Gall Fungus (*Synchitrium vaccinii*) occurs on the leaves, stems, flowers and fruit. The galls are of a red color and infested plants may become red throughout, which renders a diseased bog conspicuous. The fungus attacks also huckleberry, laurel, azalea, etc. The galls appear early in May and cause a misshapen growth of the plants. The fungus is carried by the water of the spring floods and perhaps by birds and winds. It may be partly controlled by withholding the water in winter and spring and by the burning of infected plants.



CRANBERRY BOG

Scald appears as one or sometimes, several small soft spots on one side of the berry in July and August. Later the whole berry becomes soft and brown and finally shrivels up. They may fall off or remain on the bushes in this condition. The leaves are also affected and the disease causes most damage in moist weather. Some advantage has been noted from

sanding the bog. The ditches may be kept deep and the water low in midsummer.

Black-Headed Worm, also called vine worm or fire worm, and the yellow headed worm are 2 species which feed upon the foliage. Paris green, kerosene emulsion, hellebore and pyrethrum have been used with good results in combating these pests. Flooding with water late in the spring is also beneficial.

The Fruit Worm feeds on the inside of the berries. It may be checked by spraying with Paris green just after the flowers fall.

Cranberries are also occasionally attacked by grasshoppers and scale insects.

CURRANT (*Ribes* spp.)

Perhaps the first thing to consider in making plans for raising either currants or gooseberries is that the black currant (*Ribes nigrum*), on account of its extreme susceptibility to infection with white pine blister rust should not be grown at all. It is one of the host plants and carriers of that destructive disease which threatens the extinction of the white pine group (northern and western white pine and sugar pine). Many States have prohibited the growing of the black currant and designated certain areas in which no currant or gooseberry of any kind may be grown. White pines cannot live in close proximity to currants, and white pines are more important than currants.

Under these limitations the chief areas where currants thrive are the Northern States east of the 100th meridian and the northern Pacific slope. Currants bloom early and the site of a planting should be chosen for its relative immunity to spring frosts. Most soils, if not too sandy, are satisfactory. Stable manure and wood ashes may profitably be applied up to 20 tons or more per acre of barnyard manure, or a smaller quantity of hen manure. Currants are often planted between the rows of apple trees or in vineyards, taking care that they are spaced so as not to interfere with the usual cultural attention to the apple trees and vines. Currants are grateful for shade. In the home garden they may be planted between the fruit trees and left there permanently.

As reported by G. M. Darrow, "Currants are propagated almost entirely by means of cuttings made from vigorous shoots of the current season's growth. In the Eastern States the cuttings are made about 8 inches long, and in the Pacific coast regions from 10 to 12 inches long. They are usually cut in the autumn after the leaves have dropped, and may be set in the nursery row immediately, or buried in sand with the bottom end up, or stored until spring in a cellar cool enough to keep them dormant and moist enough to prevent drying, but not so moist as to cause mold to develop on them. The cuttings may also be made during the winter or in early spring. In the latter case, they are put in the nursery at once. The cuttings should be set from 3 to 6 inches apart in the nursery row, with the soil firmly packed about them. This is done as early in the spring as the soil can be worked, whether the cuttings are made in the autumn or later. Not more than 2 buds should be left above the ground."

Currants may be planted in rows 6 to 8 feet apart and 4 to 6 feet distant in the row. Tillage should begin early and should be frequent, a mulch of straw or other material is sometimes used to replace tillage, keep down weeds and conserve moisture. When currants are not planted in orchards they may be interplanted with lettuce, cabbage, potatoes or other garden vegetables requiring intensive cultivation.

Red or white currant bushes when 1 year old should have the weaker shoots removed, and 6 to 8 strong shoots should be left, according to the vigor of the bush. At the end of the next year 4 or 5 2-year-old shoots and 3 or 4 1-year-old shoots should be left, and at the end of the third year about 3 shoots each of 3-year-old, 2-year-old and 1-year-old wood.

Red and white currants bear their fruit at the base of 1-year-old wood and on spurs on older wood. They bear best on spurs on 2-year-old and 3-year-old wood. Pruning bearing bushes after they are more than 3 years of age consequently consists in removing all branches more than 3 years old which have passed this heavy-bearing period, leaving just enough 1-year-old shoots to take their places. Pruning, therefore, in effect is a process of renewal.

In pruning varieties of spreading growth, the outer and lower shoots generally should be removed, as these branches are likely to droop to the ground so that the fruit borne on them will become covered with dirt. Varieties having an erect habit of growth, on the other hand, should be thinned by removal of the central shoots.

Enemies: The Currant Rust is the summer stage of the white pine blister rust. From late June to the end of the season spores issuing from the tiny orange-colored pustules on the leaves are carried

away by winds but seem not able to reach white pine trees if more than 900 feet distant. All currant and gooseberry bushes within 900 feet of white pine should be destroyed.

Leaf Spot (*Septoria ribis* and *Cercospora angulata*) attacks all varieties of currants and gooseberries. It appears in midsummer as small brown spots on the leaves. Experiments at the Iowa Station showed that 5 applications of Bordeaux mixture will completely check the disease. A clear fungicide like ammoniacal solution of copper carbonate may be used during the berry season. The effect of punctures by leaf bugs sometimes resembles leaf spot.

Cane Blight appears as a sudden wilting, death and drying of the canes. It begins in May and continues through the season. The fungus spreads in both directions from the point of infection. Diseased canes should be cut out and burned. In order to prevent spreading the disease in pruning, the knife should be occasionally dipped in a disinfectant solution.

Knot (*Nectria cinnabarina*) is first noted by a wilting, discoloration and drying of the foliage. Fruit clusters on affected plants are small and the berries are prematurely colored and fall off with the leaves. Small warts of a red color develop on diseased canes in the fall. Usually the canes are killed and sometimes the roots. The fungus may live for some time in canes before the symptoms of the disease appear. Cutting should therefore be taken only from plants which are known to be healthy. Diseased plants should be removed and destroyed.

Anthracnose (*Pseudopeziza ribis*) appears in June or July as small brown or black spots, chiefly on the upper surface of the leaves, which soon turn yellow and fall away. The fungus probably passes the winter in fallen diseased leaves. Such material should be burned. Spraying with standard fungicides like Bordeaux mixture will help to check the disease.

Borer (*Synanthedon tipuliformis*) is a dark blue moth with yellow bands across the body and a yellow collar. The caterpillar is white with a brown head. The moth lays her eggs in May near buds on the outer branches. After hatching the larva bores to the center of the stem and stays in the pith until the following year, when it emerges as a moth. Affected canes are easily recognized and should be cut out and burned.

Fly (*Epochra Canadensis*) is nearly as large as the common house fly, but more slender with longer wings. They deposit their eggs in the berries, and the larvae when full grown leave the berries before or after they have fallen to the ground and conceal themselves in the soil. Infested fruit should be gathered and destroyed. The pupae of the fly may be killed by deep spading in the winter. Mulching and allowing chickens to run among currant bushes has been recommended.

Sawfly (*Nematus ribesii*) is a 4-winged fly of a yellow color. The females deposit their eggs on the lower side of the leaves in rows along the vein. The young hatch out in a few days and feed on the leaves. This pest may be easily destroyed by spraying with arsenical poisons when the leaves are newly developed, or with hellebore either dry or mixed with water, after the fruit is set.

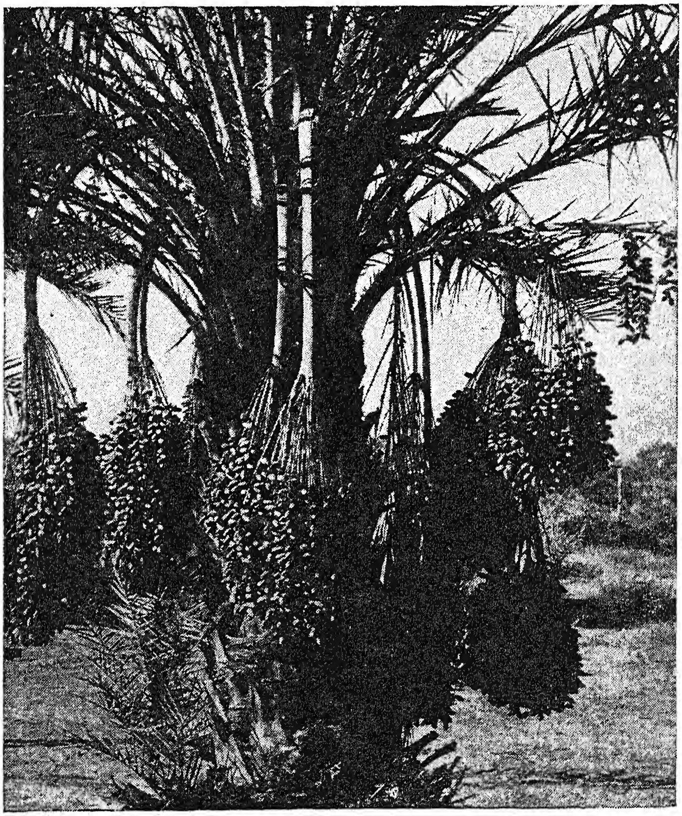
CUTTINGS

These are parts of plants used in place of seed for producing new plants. Under proper conditions they may be set in soil or water, where they take root and produce new stems. Many improved varieties of fruits, nuts, etc., do not come true to name when grown from seed, but instead produce fruit of very inferior quality. This difficulty is obviated in some cases by the use of cuttings. Plants grown from cuttings possess the same characteristics as the parent from which they were taken. According to the part of the plant from which such cuttings are taken they may be designated as stem cuttings, root cuttings, leaf cuttings and tuber cuttings. Cuttings may also be classified according to the kind of wood from which they are taken, as dormant, semi-dormant, etc. Improved varieties of grapes, currants and gooseberries are usually propagated from stem cuttings taken in the late fall or winter when the wood is dormant, blackberries and raspberries from root cuttings, potatoes from tuber cuttings and many greenhouse plants from leaf cuttings. The proper method of making and handling cuttings varies with the particular plant propagated and will therefore be considered in connection with the different plants.

DATE PALM (*Phoenix dactylifera*)

The date palm is indigenous to Arabia and Africa but is pretty generally cultivated wherever there is prolonged summer heat of 100° to 120° with low humidity. In the vicinity of Basra, at the mouth of the Euphrates, date orchards

crowd the horizon for 50 miles or more, and the annual export of dates exceeds 100,000 tons. The temperature in that region often reaches 120°. During June, July and August in Yuma and Phoenix, Arizona, and Indio, California, the average daily maximum air temperature is above 100° F. Our 206,000 date trees are mostly in California and Arizona with small planting along the lower Rio Grande in Texas.



DATE PALM IN ARIZONA

Barnyard manure supplemented with complete chemical fertilizers are applied as required, and leguminous cover crops are advantageously used. While the date palm revels in the hot sun and dry air it needs an abundance of moisture in the soil. Around Indio 8 to 10 feet of irrigation water per season is needed for a full crop, applied at intervals of 2 weeks in summer and monthly in winter.

Dates are propagated mostly by 3- to 5-year-old offsets at the base of the older trees. These offsets were originally imported from Algeria, Egypt and Iraq. Seedlings often produce a marketable fruit. About 10 per cent of the dates in California and Arizona are seedlings. The chief imported varieties are Deglet Noor, Khadrawy and Saidy.

The date palm is especially suited for culture in desert regions where climatic conditions are favorable. It is able to withstand without injury large quantities of alkali in the soil and irrigation water. This is one of its most valuable features. Trees true to name are grown from suckers. They are planted 25 to 30 feet apart each way. The male and female flowers are borne on separate plants. About 1 male is required to pollinate every 25 females. At the blooming time of the female flowers clusters of male flowers are tied among them to insure pollination and a full set of good fruit. Trees may begin to bear within 4 years after being set out, but paying quantities are not secured until the trees are 6 or 8 years old, and

full crops are not obtained until 10 or 11 years after planting. A full bearing tree produces 100 to 200 pounds of fruit per year, though sometimes 300 to 600 pounds are obtained. At the Arizona Station a tree 8 years old produced 400 pounds.

Thinning. The usual method of thinning is to cut back the tips of the strands of the female flower cluster at the time of pollination. The operation is then easily performed with a single cut, since the strands of a freshly opened inflorescence are compact and relatively tender. At the same time some growers also cut out entirely a certain proportion of the strands from the center of the cluster. However, most growers postpone the thinning out of the strands for several weeks until the bunch has begun to work its way down through the leaves. At this time some entire bunches are cut out if the number is in excess of what the grower considers desirable for the size and vigor of the palm. In cutting back the tips, and in thinning out the strands, the removal of a total of about 50 to 60 per cent of the flowers or fruits on the bunch has been found desirable.

DEWBERRY (*Rubus* spp.)

This is a trailing form of the blackberry that has come into wide cultivation. The dewberry grows wild all over the country and the fruit is indistinguishable by the general public from that of the blackberry. It is of large size, attractive in appearance, and from 10 days to 2 weeks earlier than the standard varieties of blackberries. Ripening as it does between the raspberries and blackberries, there is usually a profitable demand for the fruit. As yet, however, only a comparatively few fruit growers have undertaken its cultivation.

Some varieties of dewberries are self sterile. The Young, Lucretia and Boysen varieties are fertile and may be planted as pollenizers with the sterile sorts, alternating 2 rows of each variety with 2 rows of another sort. Bees should be colonized in the vicinity to assist in cross pollenizing.

Soils and Culture. The dewberry is found wild on the lighter, poorer soils of the country. In cultivation it succeeds best on well drained, sandy loams, though success has been reported on nearly all soils. Some varieties, like Windom and West, delight in partial shade, and a cool northern exposure is often recommended for this crop. The fertilizers required are about the same as for the blackberry, i.e., wood ashes and barnyard manure.

Dewberries are generally propagated from tips like blackberries, though sometimes from root cuttings. The tips are rooted by covering with soil about the time the shoots have completed their growth. The plants are set in rows 4 to 6 feet apart and 3 to 4 feet distant in the row, depending on the method of training adopted. The New York Cornell Station prefers training the plants to stakes 4 feet apart each way. Four to 6 canes are allowed to grow from each plant, and these are tied to the stakes with wool twine or willow thongs 2 or 3 times during the season as they grow. Where a flat 3 or 4-wire trellis is used the space between the rows should be 5 or 6 feet. The frequent failure of dewberries to set fruit is believed to be due to the lack of pollination, and it is quite generally believed that this can be overcome in a measure by planting different varieties together.

The fruit of the dewberry, like that of the blackberry, is borne on year-old canes. After these have fruited they should be cut out and the new canes which have been growing at the base of the plant tied up to the trellis. It is usual to leave these canes lying on the ground during the winter, especially in cold localities for protection. Scarcely any pruning will be required except a shortening in of the longer canes as they are tied to the trellis or post. Only 4 or 5 canes should be left in each hill. If the canes are not trained to posts, a trellis, such as is employed with grapes, may be used, or a flat trellis made of wire placed 10 or 12 inches from the ground and a foot or more in width. With some growers the canes are not tied up at all, but allowed to trail on the ground, a mulch of straw being placed underneath to keep the fruit out of the dirt. The best fruit cannot be produced in this way, but any method of training that will keep the fruit off the ground will generally be found satisfactory.

A very convenient form of trellis is that used at the Georgia Station. The wires are 2 feet from the ground and 22 inches apart. At this station a dozen or more canes are left to grow in each hill. As they become long enough they are brought up between the wires of the trellis and left to trail down over either side, the ends being clipped off so that they do not trail on the ground. "This may not be the most scientific method of treatment,

but it is certainly for this region the most economical and practical."

A plantation of dewberries will endure for a good many years. Often the vines do not come into their best bearing until the plantation is 3 or 4 years old. The yield of fruit is extremely variable. The Cornell Station places the yield of the Lucretia, when grown from 2 to 3 feet apart in 3½ foot rows, at 50 to 60 bushels per acre. Vines in the North should be laid down upon the approach of winter and covered with a few shovelfuls of earth for protection.

Varieties. There are about 20 named varieties of dewberries in cultivation. Lucretia is probably the best known and most widely grown variety followed by the Young and Boysen. It is especially recommended for New York and the Northern States generally. On the Pacific coast the Loganberry is widely grown. *See Loganberry.*

Botany. The botanical types to which the cultivated dewberries belong are stated by the New York Cornell Station as follows: (1) the Northern dewberry, or *Rubus Canadensis* (now *R. villosus*). To this type belong the Windom, Lucretia's Sister and Geer. (a) The Lucretia subtype, or variety *roribaccus,* comprising the Lucretia. (b) The Bartel sub-type, or variety *invisus.* To this belong Bartel or Mammoth, General Grant and Never Fail. (2) Southern dewberry, or *Rubus trivialis.* Here belong Manatee, Bauer, Wilson White and Austin, and probably Fairfax. (3) The Western dewberry, or *Rubus vitifolius* (known also as *R. ursinus*). Here belong the varieties known as Aughinbaugh (one of the reputed parents of the Loganberry), Skagit Chief, Belle of Washington and Washington Climbing. None of these berries have been well tested beyond the Pacific coast region.

For Enemies *see Blackberries.*

FIG (*Ficus carica*)

The fig is widely distributed from Virginia along the Atlantic Coast and Gulf States to Texas, while the Smyrna fig has become an important crop in California. Throughout the South figs are grown about farm buildings for home consumption. The largest commercial plantings are in California and Texas.

North of the Carolinas some kind of winter protection, such as covering with pine boughs or earth, is necessary. With some winter protection figs are grown as far north as Maryland. Figs are eaten in the fresh state as a dessert, but the taste for them, except in the South, is an acquired one. Fresh figs are seldom ever seen in the northern markets, since they ripen at a time when other fruits are plentiful, are uninviting in appearance, do not stand shipping well, and most people do not like them until they have learned to. Canned figs are in constant request and the supply seldom ever equals the demand. It is in dried condition, however, that figs are most widely known. California is practically the only State producing dried figs in commercial quantities in this country.

Soil. The best soil for figs is warm, moist well drained loam, well supplied with lime, potash and phosphoric acid. In California the experiment stations have found that the fig is strongly resistant to alkali, being nearly equal to the date palm in this respect.

Propagation. The fig is usually propagated from hard wood cuttings of the previous season's growth. These may be of almost any length, but will grow from single eye cuttings. The cuttings are made and handled like grape cuttings. In California cuttings are set in the nursery in December or January and should be long enough so that the lower part will be in moist soil constantly. The upper bud should be just at the surface of the soil. Cuttings will be ready for the nursery within a year. In the Southern and Eastern States cuttings may be set out in the open in April or May, or started earlier with bottom heat.

Fig trees in California grow to a very large size, some old trees having trunks 2 feet in diameter. In the orchard the smaller growing varieties are usually set 25 feet apart each way and the larger ones 40 feet. In the East the trees are largely grown close together as shrubs. No pruning further than the removal of dead branches and sufficient to keep the tree open to light and air is necessary. Shallow cultivation is practiced in the orchard, and while the trees are small some intercultural crop is grown.

In the Southern States the most prominent varieties grown are Celeste, Brown Turkey and Magnolia, and in California White Adriatic, Black California, White Marseilles and the Smyrna fig. The successful culture of this latter fig is of so peculiar a nature and of so much importance that it requires special mention.

Smyrna Fig. The Smyrna fig is the commercial fig of the countries lying east of the Mediterranean Sea, and is the dried fig of commerce in this country. It is

propagated and cultivated like the common figs mentioned above but the fruit does not set unless fertilized with pollen from wild fig trees, or Capri figs, as they are called. The Capri fig is of no value whatever as a table fruit, but within it develops the fig wasp (*Blastophaga*), the female of which carries the pollen from the wild flowers to the flowers of the Smyrna fig, thus cross fertilizing them and making the development of fruit and seed possible. Each Capri fig contains an enormous number of wasps. At the proper season from 15 to 30 of these figs are hung in the branches of each Smyrna tree. As the female wasps come out of the figs to find other blossoms in which to lay their eggs they are covered with pollen. In their endeavor to find Capri fig blossoms many enter the Smyrna figs. The eye of the Smyrna fig is very small, and the wasps in getting into the blossoms lose their wings. They crawl clumsily about inside the fig blossom to find a place to deposit their eggs, and in doing so the pollen from their bodies is brushed off on the pistils of the Smyrna blossoms, thus fertilizing them. The wasp dies inside the fig and is absorbed by it, as are also the eggs she may lay. The Capri fig tree is absolutely essential for the perpetuation of the wasp, and it requires about 2 Capri fig trees to every 100 Smyrna trees. The successful introduction of the fig wasp into this country was accomplished by the United States Department of Agriculture in 1899. Previous to that period only a few Smyrna figs were grown, and these by means of hand pollination. During recent years tons of Smyrna figs, rivaling in quality the best Smyrna figs of the old world have been grown. California produces ⅔ of the U.S. crop of figs. The complete account of the new industry thus successfully established in America by the introduction of this minute insect forms one of the most interesting chapters in the history of fruit culture in this country. Fig trees of ordinary varieties can be easily grafted over with Smyrna or other improved varieties. The limbs should be cut back to within 18 to 24 inches of the trunk, allowing at least 2 to remain intact on the south side of the tree to afford shade for the cions until the following year. From 2 to 4 cions 5/16 to ½ inch in diameter, and preferably from 2-year-old wood, should be inserted on each stock. A V-shaped piece of bark 1 to 1¼ inches long should be removed from the stock and the cion cut to fit snugly into the V. It should be tied firmly in place by 5 or 6-ply cotton twine, and the wound, stub, and top of the cion well covered with liquid grafting wax. After the cions have united the strings should be cut.

Enemies: Fig leaves are often attacked by yellow and red rusts. Diseased spots fall out, leaving holes in the leaves. Spraying with Bordeaux mixture is the best remedy.

The Fig Beetle (*Allorhina nitida*) is about 1 inch in length and of a green bronze color. It appears when the fruit begins to ripen and attacks the fruit, sucking out the juices. The beetle may be jarred into vessels containing kerosene. The jarring should be done in early morning while it is cool.

When adult June beetles are present in large numbers they may be destroyed as recommended for the fig beetles.

FILBERT

Filbert is the preferred name for cultivated varieties of hazelnut of European origin now cultivated chiefly in Oregon and Washington, nearly 90 per cent of the orchards being in Oregon near Forest Grove, and other localities. The native American hazelnut is a familiar shrub of wide distribution in old pastures, fence rows and clearings. The nuts mature in the fall and may be gathered after the first frost, but are small and seldom come upon the market, being gathered mostly by children.

The commercial crop of filberts amounts to about 5000 tons annually. A yield of 1500 to 1800 pounds per acre of 7-year old trees is considered satisfactory.

Hazelnuts are propagated by seed, cuttings, layering and grafting. The seed of improved varieties does not "come true." Propagation by cutting is most usual. These are cut 8 to 10 inches long from last year's wood and rooted in moist, sandy soil in the same manner as currants and gooseberries. Grafting the improved varieties on the common hazelnut is sometime practiced. By this process the fruiting period is materially hastened. In Oregon cuttings 15 to 20 inches long are recommended, and all buds except 2 or 3 at the upper end, carefully removed. Where this precaution is observed it prevents the plant from throwing up suckers, which it has a tendency to do. In the nursery row the sprouts and branches are kept removed from about the base to a height of 12 inches. At this height the head of 5 or 6 stems is allowed to develop on the main stem. After 2 years in the

nursery rows the trees are set in the permanent orchard 15 feet apart each way. Hazelnuts grow on nearly all soils, but fruit most abundantly on the lighter loams.

Pruning is essential to the largest production of nuts. Young shoots should be cut back to about half their length each winter. This induces the formation of laterals along the main branches, on which the fruit is borne.

On account of the habit of filberts to produce suckers at the base of the tree, a system of mound layering may be used to propagate the trees. By cutting the suckers half off on the side toward the tree, they may be bent down on the ground, having previously pared off the bark on the outer side of the sucker and trimmed off the tip end. This operation may take place from January to early spring. Young shoots start from the buds on the suckers and, as soon as they reach a few inches in height, sandy soil to a depth of 2 or 3 inches is placed about the base of these shoots which should become about 2 feet long in September. They may then be dug, transplanted into trenches and will be ready for their permanent place in the orchard the next year. This production of suckers is a heavy drain upon a bearing tree, and experiments are in progress in the use of the Constantinople hazel as a stock to develop trees that will not send out suckers at the base.

FROSTS

Whenever serious damage over a wide area is done by frost the event becomes first page news. Generally the extent of the destruction is grossly exaggerated in the first reports and the public resigns itself to the prospect of paying more for strawberries, peaches and early tomatoes. Orchard fruits are usually prominently mentioned in such news items. It is, however, a matter of common knowledge that apple and peach trees, as well as most other deciduous fruit trees, produce enough blossoms to endure a loss of 80 per cent of them without endangering a full crop of fruit. If one bloom in five develops a mature fruit it will be all the tree can bear. Nature thus produces five times as many blossoms as necessary to provide against emergencies. And these blossoms do not all open at the same time. It is practically impossible for a single frost to destroy a fruit crop. Usually there is but one killing frost after fruit trees are in bloom. Ordinarily that means that at the very worst only the early blooms of each cluster are killed, leaving the unopened buds to come on later. Within recent memory the year 1921 was the only one in which several killing spring frosts occurred in relays, spaced so as to do most damage. In that season the Delaware peach crop and the Virginia apple crop were badly caught. The freeze of March 28 and 29 did its worst, but many late buds escaped and were giving cheerful promise when the freeze of April 10 and 11 caught them, leaving only a few much belated buds. Even that hope was nipped by a third freeze on April 16 and 17.

In a tabulation of the flowering dates of apples in northwestern Ohio from 1883 to 1912 it was shown that the earliest date for the first bloom was April 17, the latest May 18, and the average May 7, while the date of the last spring freeze ranged from April 9 to May 29.

Records of the dates of early fall frosts and late spring frosts have been collected by the Weather Bureau for most farming localities throughout the country. Old timers in every community have these dates in mind as a guide to the time for planting and harvesting crops which may be affected by frosts. It is wise for the newcomer to get this information for guidance till he becomes familiar with the weather in his locality. In any event it is worthwhile to be weather-wise. The housewife stands guard over her flower and kitchen garden and covers the most sensitive plants with paper or other material at the threat of frost. Irrigators in the Western States have found that flooding an exposed orchard or other crop on the evening of a threatened frost often prevents the temperature from falling below the danger line. And the use of orchard heaters or wood fires has long been practiced in citrus orchards. In Florida wood fires in alternate squares of the citrus orchard have given satisfactory protection against frost at very small expense. California citrus growers rely on various shapes and sizes of metal pots in which oil or coke is burned. The process was called smudging in early years and it was thought that frost protection depended upon floating a cloud of smoke through the orchard. Recently, however, it has been found that the heat and not the smoke is the salvation of the orchard and the effort now is to operate the heaters as smokelessly as possible.

GOOSEBERRY

The first step in gooseberry growing is to remember that, like currants, it is a host plant that may transmit blister rust to white pines and that the plants may be destroyed by State authority if they stand within 900 feet of a grove of white pine.

The gooseberry is one of our hardiest fruits, and since methods have been found to control the mildew which often seriously affects it, the crop is one of the surest and easiest to grow. The best soil for gooseberries is a rich, rather heavy clay loam, well drained. In garden culture they will do fairly well on almost any soil.

Propagation and Culture. Gooseberries are generally propagated by suckers and mound layering, though the American varieties grow easily from 8-inch cuttings of new wood fairly well matured taken in October. In small garden practice, rooted canes may be separated from old plants and set out. These grow readily. Nurserymen generally propagate by mound layering. In this process old plants, called "stools," are well headed back. Many new shoots are soon sent up in the spring, and when these become fairly well hardened, along the last of June or first of July, they are crowded outward and the center of the stool covered with earth to about 4 inches above the base of the shoots and well packed down. In the fall or the spring following the rooted shoots are removed from the mother plant and transplanted to the permanent plantation. There they should stand about 5 feet apart each way to permit of cultivation in both directions, or 3 to 4 feet apart in rows 5 to 6 feet apart. Gooseberries are sometimes set between the rows in orchards. In such cases they should not be planted nearer the trees than 6 feet. In setting out plants all broken or bruised roots should be cut out smoothly, and the tops shortened to correspond with the amount of roots. Gooseberries may be trained to a low tree form with a single main stem, but the more usual method is to train to a bush form. In the former method all the eyes or buds on the cutting or layer are removed on that portion of the stem below ground, while by the latter method they are left on and thus produce many suckers for renewing the older canes later on. But little pruning other than a short clipping back of the shoots is required for the first 2 or 3 years. The object of the clipping is to develop fruit spurs along the canes. Further pruning consists in the removal of weak or broken branches and old canes that have passed their most fruitful period, and the keeping of the bushes in the best form for cultivating, gathering the fruit, spraying etc.

Well-rotted stable manure is one of the best fertilizers. The plants require no winter protection. They need shallow cultivation throughout the growing season.

Gooseberry fruit is marketed both green and ripe. The green fruit is the more easily picked. The vines are rapidly stripped and the fruit run through a fanning mill to free it from leaves, sticks, etc., after which it is packed in baskets for market.

Botany and Varieties: Two classes of gooseberries are grown in this country, the European (*R. grossularia*) and American (*R. oxyacanthoides* and *R. cynosbati*). Relative to the merits of these 2 classes the New York State Station states as follows: The European class shows superiority in the large size and the variety of colors of the fruit and in the early marketable condition of the green crop. The European varieties are preferred at fruit-preserving establishments. The best of the American varieties are superior to the European gooseberries as a class in productiveness, hardiness, ease with which they may be propagated, quality, delicacy of flavor and thin texture of the skin of the fruit, and freedom from mildew.

Of the European varieties, Industry, Chautauqua, Portage, Columbus and Triumph are considered among the best, being strong growers and very productive. Crown Bob is an excellent variety for early market. Lancashire Lad is a vigorous variety, suffering but little from mildew. Other good varieties are Wellington Glory, Dominion and Triumph. Of the American varieties Downing stands at the head in productiveness and is rarely troubled with mildew. Other good varieties are Houghton, Carrie and Poorman.

Enemies: Powdery Mildew (*Sphaerotheca morsuvae*) first appears on the young half-grown leaves and terminal buds. Affected parts are covered with a white powdery substance. The berries are attacked in the same manner, usually on one side, and become irregular in shape. Experiments with formalin, lysol, Bordeaux mixture and potassium sulphide indicate that potassium sulphide is the most effective fungicide for this disease. It should be used in the proportion of 1 ounce to 2 or 3 gallons of water. Spraying

should begin just as the buds are unfolding and should be repeated at intervals of about 10 days.

Rust (*Aecidium grossulariae*) appears as bright yellow swollen spots on the leaves of gooseberry and cultivated currants in spring or early summer. It is usually not very harmful and may be controlled by picking and burning affected leaves.

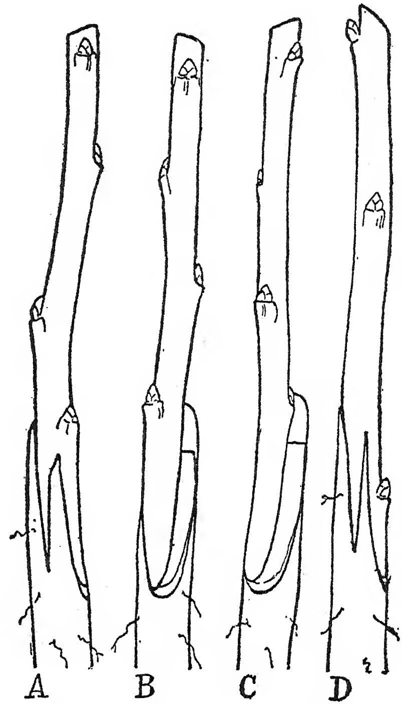
Fruit Worm (*Dakruma convolutella*) is the larva of a gray moth which lays its eggs on gooseberries in early spring. The pale green larvae feed within the berries and cause them to turn red and fall prematurely. When one berry is destroyed the larva enters another, fastening the berries together by silken threads. Infested berries should be picked off and destroyed. Bushes should be dusted with air-slaked lime in April and May, when the eggs are laid.

For other insect pests *see* under *Currant*.

CRAFTING

This is the process of inserting a piece of plant, usually a bud or twig, in another so that it will grow. Grafting is employed to propagate varieties of fruit, nuts, etc., that do not come true from seed; to change over orchards, already established, into more desirable sorts; to dwarf plants; to grow tender sorts on hardy roots or in adverse soils etc. It is necessary practice with nearly all orchard fruits, most nuts, the European varieties of grapes grown in most places in this country, and with many ornamental shrubs, etc. The plant on which the grafting is done is termed the stock, and the part inserted into the stock is called the cion, though by cion is usually understood a twig consisting of 1 or more buds rather than detached buds. The essential principle in grafting is to bring the cambium layer (growing tissue between the bark and wood) of the cion and stock in close contact with each other and to keep them there until they grow together. There are innumerable methods of grafting, but these may be classified as (1) budding, (2) cion grafting, and (3) grafting by approach.

Budding. Budding is practiced with peaches, cherries, plums and most stone fruits, and in eastern nurseries apples and pears are largely budded. It consists in inserting a single bud under the bark of the stock. It is practiced more especially with small stocks 1 or 2 years old. Older trees are cion grafted or the larger limbs are cut back and the sprouts allowed to grow for a year and these then budded. Budding is usually performed in July, August or September, when the bark of the stock is loose and will peel. It may also be done in the spring. One-year-old nursery trees are budded 2 or 3 inches above the ground, and preferably on the north side of the stock. If budded in the



SHOWING TOP BUD POSITION

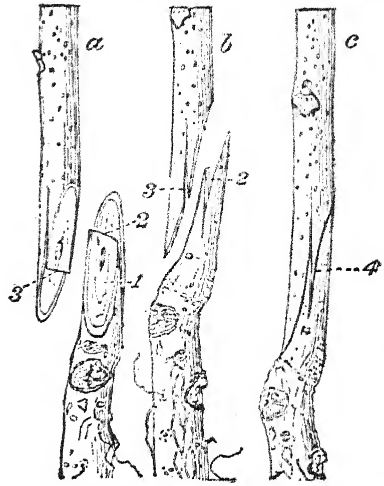
spring the buds are taken from twigs of the previous season's growth, and if fall budded from the growing twigs of the season. A T-like cut is made through the bark of the stock, the bark then is slightly lifted near the top of the cut and a little piece of bark containing the bud is inserted and pressed down so that it is held firmly in place. The bud is then tied firmly in place with raffia, a cheap commercial tying material, or some soft yarn. No wax or other covering material is used.

The stock is prepared for budding by stripping away the lower leaves and twigs from the area to be budded. The bud should be cut from the twig with a sharp, thin-bladed knife. Only the bark is required, but just underneath the bud the operator should cut a little into the wood. Small buds will be found in the axils of

the leaves. These leaves should be removed at once, leaving only a small part of the stem as a handle. Special care is required that the buds do not dry out. They should be left on the twig, or bud stick as it is called, until wanted for use. The bud usually "takes" in 2 or 3 weeks, after which, in the case of fall budded trees, the stock above the inserted bud should be cut away entirely about an inch above the insertion and all other buds removed.

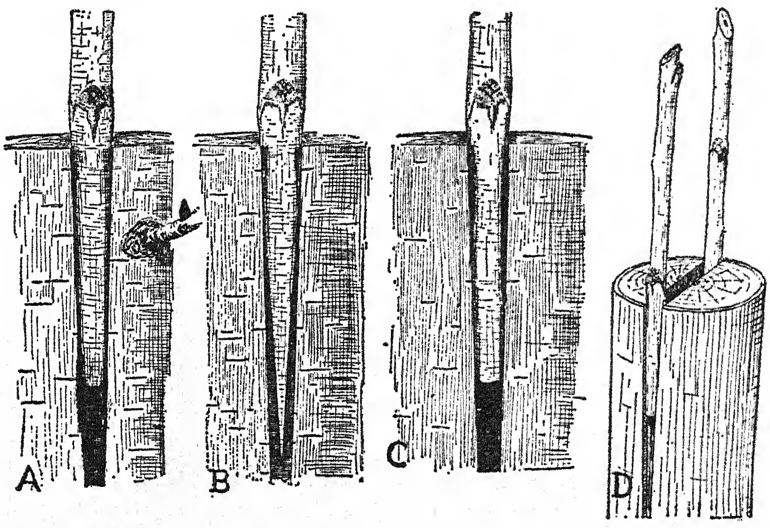
Cion Grafting. There are an infinite number of ways of uniting cion and stock in cion grafting, but the more common are the cleft graft and the whip or tongue graft. Cleft grafting is practiced with rather large branches and is done early in the spring. The cions are taken from the shoots of the previous year's growth, and generally consist of 3 buds. They are made some time previous, tied in bundles, labeled, and kept stored in some cool place to keep them perfectly dormant. The wedge-shaped part of the cion should be a little thicker on the outside so that the pressure of the cleft will hold the cambium layers of stock and cion in close contact. Two cions are usually set in each stock, with the lower bud of the cion near the top of the wedge. This bud, though usually covered with grafting wax, is the one that most frequently grows, since it is nearest the supply of food material furnished by the stock. Should both cions grow one may be removed later if it is found desirable.

The wax used for covering over the wound is made by melting together beeswax, tallow and resin. A very good formula for outdoor use is made of 1 pound tallow, 2 pounds beeswax and 4 pounds of



SPLICE OR WHIP GRAFT

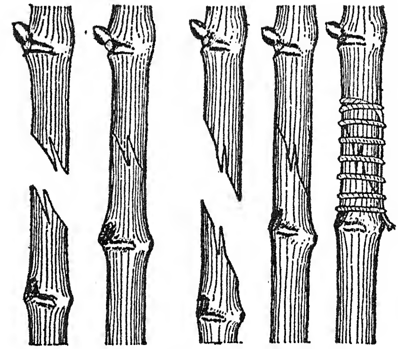
resin. The melted mixture should be poured in a pail of water and pulled with greased hands until it becomes light colored and grains. It may then be put away in oiled paper and will keep indefinitely. The warmth of the hands will be sufficient to soften it for use in the orchard. The hands must be greased to



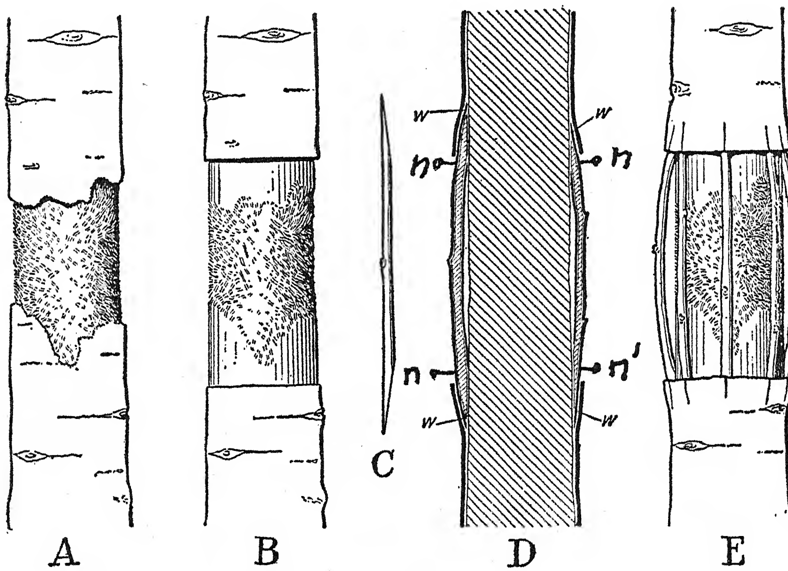
A, PROPER SCION; B, SCION TOO LONG; C, POOR CONTACT;
D, SCION READY FOR WAXING

prevent it from sticking to them. The wounds should be covered air tight with the wax.

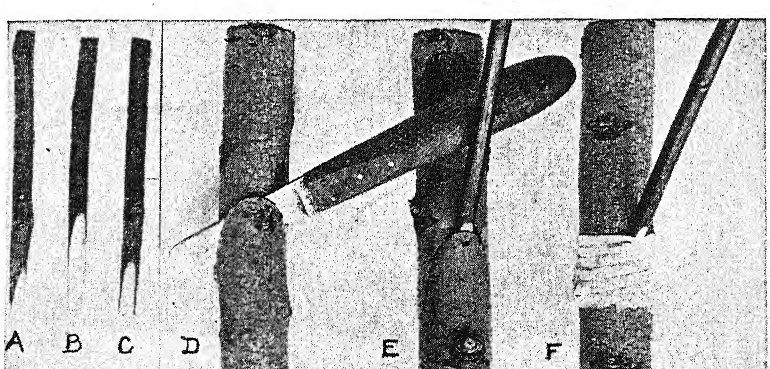
Whip or tongue grafting is commonly employed in grafting seedling apple roots with improved varieties and with other small stocks. The cion and stock in whip grafting should be approximately the same size. In root whip grafting the parts are held firmly in place by a few wraps of cotton yarn drawn through melted wax and wound up on a spool. In root grafting with apples, thrifty one-year-old stock is taken up in the fall and stored in a cellar where it will keep moist. Some time during the winter these roots may be cut



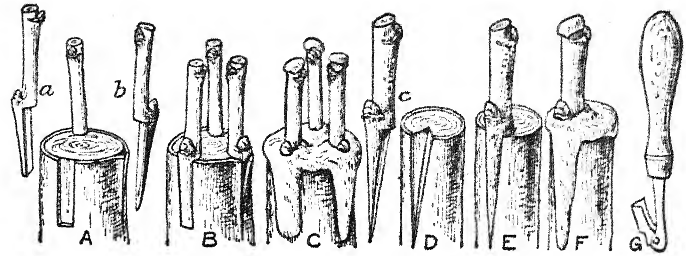
WHIP GRAFT OF GRAPE



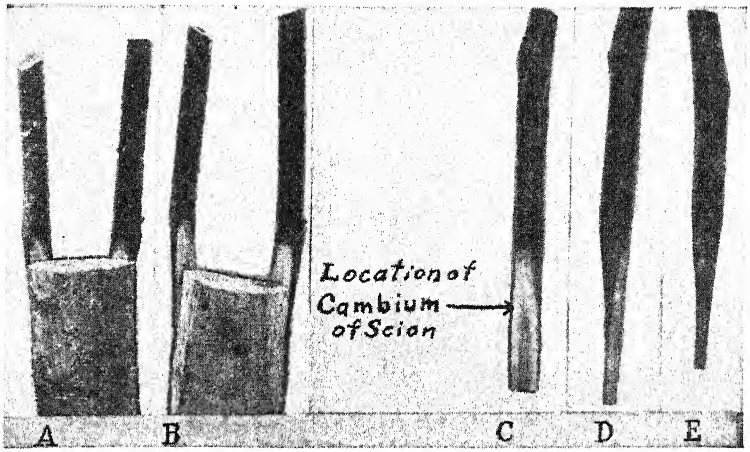
STAGES OF BRIDGE GRAFTING



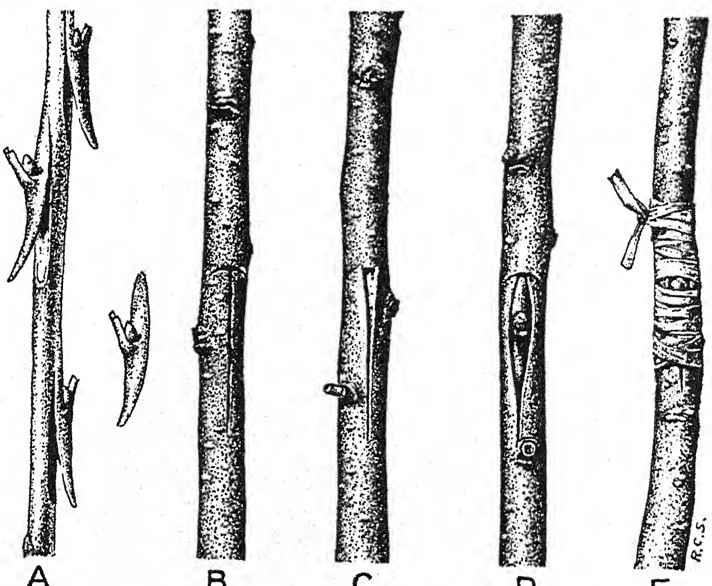
STAGES OF SIDE GRAFTING



STYLES OF CROWN GRAFTING



CLEFT GRAFTING

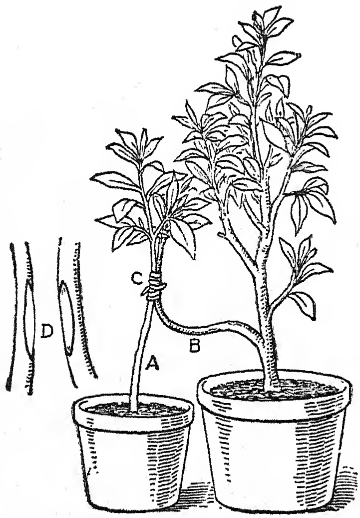


SHIELD BUDDING

in 2 or 3 pieces and each piece grafted with a cion. These root grafts are then tied in bundles and packed in moist earth until spring, when they are set in the nursery row. A method of side grafting is frequently employed in greenhouses.

Bridge grafting, as its name implies, consists in bridging over by means of cions the girdled trunks of orchard trees due to rodents or mechanical injuries from tillage implements. All dead bark at the upper and lower edges is trimmed away. Several cions are cut a little longer than the space to be spanned, thinly beveled at either end, and inserted under the healthy upper and lower edges of the decorticated belt. It should be done in early spring. Apple trees are more frequently girdled than other orchard fruit, and bridge grafting is also applicable to citrus trees.

Grafting by Approach. By grafting by approach or inarching, two branches are brought together and united without detaching either branch from the parent plant. This is accomplished by making suitable wounds in the branches and

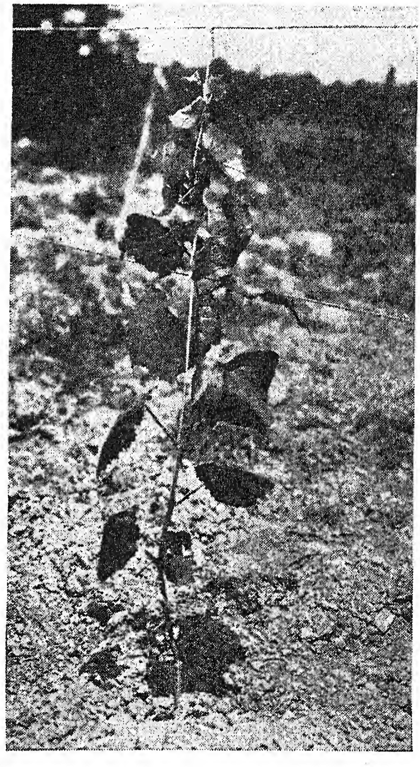


INARCHING OF POTTED PLANT

bringing them together so that the cambium layer of one will come into intimate contact with the cambium layer of the other. The branches are then bound together at the point of contact and waxed. When the cion has united with the stock it is cut off below the union and the top of the stock removed. This method of grafting is but little used.

GRAPE (*Vitis* spp.)

Grapes are by nature climbers and ramblers. Among the 30 or more native wild species of the U.S. there are some that climb to the top of the tallest forest trees, others that crawl over the ground indefinitely, or upon shrubbery or trellises, as in the old Mission enclosures in



GRAPEVINE TRAINED ON WIRES

California, or may be trained into any form which the vineyardist desires. They may not only be trained to run on trellises of various sorts, or as a bush form tied to a stake, or be pruned back to stubby form in orchard rows or, as in Syria, laid down prostrate on stones within 6 inches of the soil.

Grapes are grown in the arbor of home gardens in all States, but, as in the case of many other fruits, commercial production is largely limited to specialized localities, particularly in California, New York and Michigan, 90 per cent being grown in California. The only other extensive region lies along the Great Lakes from New York to Michigan. With reasonable attention grape vines bear every season

beginning at the age of 3 or 4 years and continuing indefinitely. There are vine trunks over a foot in diameter in California, with vigorous ramifications yielding good crops.

The best grape district of Michigan is located on sandy loams. The same type of soil is considered best in Texas, provided it is deep and underlaid with a gravelly clay subsoil. Vines cannot have too much sun. Too little sunshine will result in sour grapes.

Propagation. Grapes are propagated by seed, layers and cuttings, also by grafting. Varieties do not come true to name when grown from seed, but do when grown from layers or cuttings. Grapes may be layered either in the early spring or late summer. The spring is preferred. A cane of last season's growth is laid in a trench 2 to 3 inches deep and pinned down to the ground. When the shoots from this cane have grown 6 to 12 inches the trench should be filled with good fine soil and well tamped down. Thus treated the canes make both shoots and roots at each of the joints. The following spring these may be separated from each other and planted in the permanent vineyard. This is the surest way of growing grapes, but is not so simple as growing from cuttings.

Grape cuttings should be made after the leaves drop in the early fall from well-matured wood of the present season's growth. Each cutting should have at least 2 joints. The cut at the lower end should be made just below a joint, and at the upper end an inch or 2 above a joint. The cuttings thus prepared should be tied in bundles and buried in well-drained soil over winter. In the spring the cuttings should be planted about 2 inches apart in loose, rich soil and at a slight angle. The planting is most easily done by thrusting a spade in the soil at an angle of about 30° and pressing the soil forward. The cuttings are then inserted so that the tops are about level with the soil surface. The spade is then withdrawn and the soil pressed firmly with the heel about the lower ends of the cuttings. The rows of cuttings should be about 4 feet apart. During the summer they should make a growth of 2 to 8 feet in length and be ready for transplanting to the permanent vineyard either in the fall or the following spring. This is the usual method of propagating such varieties as Concord, Niagara and most of the varieties of grapes grown in the eastern part of the United States.

Planting. One or 2-year old vines may be used. At planting time the tops should be cut back to 3 or 4 eyes and the roots well shortened in. Large holes should be dug so that the roots may be about 6 inches below the soil surface and well spread out. Fine soil should then be worked around them and well firmed down with the feet. The vines should be set 6 to 8 feet apart in rows 8 feet apart.

Pruning. The first season let the vines grow at will. The following spring prune back the strongest cane to 3 or 4 eyes and remove the others. After the buds start in the spring leave the 2 strongest shoots to grow and rub off the others. These 2 shoots should be trained to a stake, or spread horizontally on a trellis, and left to grow during the summer. They are the canes which are to form the permanent arms of the vine. They will bear the upright shoots from which the fruit of succeeding years is to be obtained. From now on the principle to be remembered in pruning grapes is that the fruit never grows on last year's wood, but always on the new wood of the present season's growth, which springs from wood grown the preceding season. The fruit is borne near the base of the shoots. Each shoot should bear only 2 to 6 clusters, but only a limited number of clusters—from 30 to 80—should be allowed to develop on one vine. The pruning is done any time from December to March. If a vine is strong enough to bear 30 clusters of grapes about 15 buds should be left at pruning time, and if strong enough to bear 80 clusters 40 buds should be left.

With these principles in mind it will be seen that the essential operation in pruning grapes is to cut back a limited number of the best canes to a few buds each season and entirely remove the others. The more usual method at the present time is to cut the canes back to 8 to 10 buds and to leave but 3 or 4 canes, all of which should start from near the head or trunk of the vine. New arms should be taken out from year to year as the bearing wood gets farther from the trunk.

Training. There are many methods of training grapes, the more usual is to train on a trellis made of 2 or 3 wires, the top wire being about 5 feet from the ground, the bottom wire 2 feet or a little more, and the third wire intermediate between these. The 2 arms of the vine may be tied to the lower wire and the shoots trained to the upper ones, or the arms trained to the upper wire and the down-

ward-growing shoots fastened to the lower wires.

In the South the better method is to fasten 2 by 4 horizontal cross-pieces 2 to 2½ feet long to posts, and stretch a wire on either end of these cross-pieces. A third wire is stretched either along the center of the cross-piece, when it becomes known as the "horizontal system" of training, or to the post 6 inches below the cross-piece, when it becomes known as the modified "Munson system" of training. The arms are tied to the center wire in either case and the shoots trained over the other two.

Cultivation and Manuring. Grapevines require frequent shallow cultivation throughout the season. In cold latitudes, as in Wisconsin and northern Michigan, the vines should be taken down off the trellis about the middle of October and pruned. The whole vine should then be bent down to the ground and covered with earth 4 or 5 inches deep. The object of the earth is to keep the vines frozen all winter rather than subject them to repeated freezing and thawing. It is recommended to keep the vines covered as late in the spring as possible but to uncover before the buds swell enough to break off in uncovering and tying up.

Grapes do not require stimulating fertilizers. Wood ashes, about ½ bushel per vine, is one of the best fertilizers to apply. An application of 3 pounds per vine of the following mixture is recommended by the Georgia Station: 90 pounds acid phosphate, 90 pounds kainit and 20 pounds cottonseed meal.

Ringing. Grapevines are frequently girdled or ringed for the purpose of hastening maturity and fruitfulness. Experiments at the New York State Experiment Station and Massachusetts Agricultural College show that fruit on ringed vines is sometimes 10 days to 2 weeks earlier than on unringed vines and larger both in bunch and berry. Shoots bearing the bunches are ringed between the fruit and the arm bearing the shoot. Sometimes an entire arm is ringed, but the process is a devitalizing one which should not be practiced with the same vine at most oftener than every other year. The ringing should be done when the grapes are about ⅓ grown, a ring of bark about an inch wide being removed from the arm or shoot.

The three chief viticultural areas of the U.S. differ not only in methods of propagation, culture and harvesting, but in the predominant varieties which are grown. In the native grape region of the Great Lakes and Northeastern States grapes are grown primarily for table use or turning into juice. The varieties raised in this area are numerous but Concord, Delaware, Niagara, Catawba, Clinton, Worden etc. are most familiar. In the Muscadine grape region of the Gulf and Southwestern States the Eden, Mish and Scuppernong are leaders. In the Pacific Coast vinifera areas the varieties are legion. Tokay, Malaga, Riesling, Sultana, Mission, Muscat and Palomino readily recur to mind.

At present about 45 per cent of California grapes are dried, 32 per cent crushed for wine, and 10 per cent go into grape juice, leaving only a mere trace for fresh table use.

Various varieties of the native Rupestris and Riparia, more particularly Rupestris St. George, Riparia Gloire de Montpellier and Riparia Grande Glabre, have been found most resistant and best suited as stocks for the European grapes. The usual method is to grow the native stocks, then cleft-graft at the crown with the European varieties. The California Experiment Station has shown that with many varieties bench-grafting the resistant vines is more satisfactory. The stock cuttings are ¼ to ½ inch in diameter and 6 to 9 inches long. The buds from these are cut out deeply to prevent the growth of suckers. The cions are made about the same size and length, but of course the buds are not removed. The English cleft graft, tied firmly with raffia, has been found most satisfactory by the station. The grafts may be either calloused in sand and then transplanted to the nursery, or planted in the nursery at once after the manner of planting grape cuttings in the East. The best results are secured however, when the grafts are first calloused in the sand. All roots arising from the cions must be removed for the first 2 or 3 years. In planting vineyards on resistant stocks it is essential that the ground be plowed about twice as deep as where European varieties are grown on their own roots. Neglect of this principle has resulted in many failures. California methods of pruning vinifera grapes are considerably different from methods observed with native grapes. The grapes are pruned to low, stocky stumps. The canes are either not trained at all or are trained to stakes. Trellises are not used.

Enemies: Anthracnose (*Sphaceloma amphelinum*) attacks all green parts of the vine during the growing season. On grape shoots the trouble appears as

sunken oval areas. Black or brown spots appear on the leaves and the diseased tissue often cracks leaving ragged holes. On the fruit the disease appears as brown spots with a narrow, dark margin. The vines and stakes may be washed with a solution of copperas in winter and spring. In addition to this treatment regular summer applications should be made with standard fungicides.

Black Rot (*Guignardia Bidwellii*) first appears as brown or black spots on the leaves and shoots. Soon afterward the berries are attacked and finally become black, hard and leathery. This disease may be completely controlled by repeated sprayings with Bordeaux mixture, beginning before the first symptoms are noted.

Root Rot (*Ozonium auricomum*) attacks also alfalfa, cotton, apple, peach and other trees. Grasses, sorghum and corn are resistant. Sorghum for 2 or 3 years on the land reduces root rot infestation. Grapes should not be planted on newly plowed sod land. For grafting resistant stock should be used, such as Champanel or La Pryor, according to Texas experience.

Phylloxera is a common insect on wild grapes in this country, and after its introduction into Europe attracted much attention on account of its ravages upon cultivated varieties. It occurs in 2 forms, one producing galls on the underside of the leaves, and the other living upon the roots, where it causes similar swellings. The latter form causes the real injury, although it is less frequently seen than the leaf form. The root galls first appear on the small rootlets, but ultimately the whole root system is destroyed and the plant dies. The species is distributed by means of winged females, which fly to new vines in late summer or fall. In California the species has recently become injurious to the less resistant varieties of cultivated European grapes. The commonest method for combating this insect consists in the use of bisulphid of carbon in the soil. This substance is injected from 8 to 12 inches below the surface and the fumes destroy the insects. The most satisfactory method of preventing injury from phylloxera is to use resistant stock, of which the wild varieties *riparia, aestivalis* and *labrusca* are most important.

Rose Chafer (*Macrodactylus subspinosus*) is a brown beetle ⅓ of an inch in length, which appears in large swarms, eating the blossoms and leaves of grapes and many other species of plants. The immature stages of this insect are passed in grass lands, where it feeds upon the roots of grasses. Spraying with arsenicals is of avail only when the beetles are not numerous. Nearly all substances applied to the vines to render them distasteful to the beetles have proved useless. Vines may be temporarily protected with netting. Since this beetle is especially fond of the flowers of spiraea, this plant may be grown in the neighborhood of vineyards and the insects collected from these plants. They may be gathered in large beating nets or jarred into funnel-shaped collectors.

Berry Moth (*Eudemis botrana*) attacks the fruit while young and feeds upon the inside of the berries, causing discolored spots which are visible from the outside. The berries are fastened together by threads spun by the larvae of this insect. When full grown the larva leaves the fruit and rolls itself up in a portion of the leaf, in which it changes to a chrysalis. This insect attacks all varieties of grapes, but is especially injurious to the varieties with thinner skins. The first brood is rarely noted. Spraying with poisons is not practicable except for the first brood, which feeds on the green parts of the vines. Infested fallen fruit should be collected and destroyed, and fallen leaves should be burned in the autumn.

Saw Fly (*Sclandria vitis*) in the larval condition is about ½ of an inch in length and of a yellow green color, with black spots. When present in large numbers the larvae may be destroyed by arsenical poisons or white hellebore.

Leaf Hoppers. These insects belong to the same general class with plant lice. They are usually of a pale yellow or green color, are about 1/10 of an inch long, and the young resemble the adults except in size and in the lack of wings. They feed in all stages on the leaves of plants. Leaf hoppers attack cereals, grasses, other forage plants, fruit trees, etc. When present in large numbers they cause the leaves to turn yellow and die. On grasses they may be very injurious.

Spraying with pyrethrum, kerosene emulsion or tobacco decoction is effective against leaf hoppers. In greenhouses they may be destroyed by fumigation with tobacco, pyrethrum or hydrocyanic-acid gas. They may be captured at night by lantern traps. The use of a hopper-dozer, as recommended for locusts, is also a good remedy. The eggs are prevented from hatching if the grass is cut while quite green. Badly infested fields should be burned over in fall or winter.

GUAVA (*Psidium guajava*)

Guava is a bush or tree indigenous to tropical America, ranging from 3 to 20 feet in height. The fruit is 2 to 4 inches in diameter with a yellow rind when ripe, somewhat resembling a lemon. The flesh of the fruit is pink and full of seeds. It is well adapted for use in making jams and jellies and a considerable industry in the manufacture of those products has been established in Hawaii, Cuba, Porto Rico, Florida and elsewhere. There are about 45,000 guava trees in bearing in Florida. The strawberry guava is a smaller tree, bears smaller crimson or maroon colored fruit and is less desirable for use in making jams, but is of more delicious flavor for eating as a fresh fruit.

HICKORY (*Hickoria* spp.)

In the Northern States the shagbark (*H. ovata*) and shellbark (*H. laciniosa*) are the most common forms of this nut tree, while in the Southern States the pecan (*H. pecan*) is the variety of most value. So much attention has lately been given to the culture of the latter nut that it will be considered more at length under that head. *(See Pecan.)*

The hickories are native forest trees, growing wild from southern Maine west to Minnesota and south to the Gulf States. The wild nuts vary much in size, form, quality and thickness of the shell. It is probably owing to the rather thick shell, taken in connection with the slow growing habit of the trees and their difficulty of propagating by grafting and budding, that so few varieties have been introduced into cultivation. Practically all the nuts of commerce are from wild trees. Of the few varieties brought into cultivation, Hale's Paper Shell and Ideal are among the most valuable. The desirable qualities of a hickory nut are a thin shell and a meat of good quality easily gotten out. The shellbark and shagbark are cultivated and propagated the same as the pecan. (*See Pecan.*)

Since the shagbark hickory is such a slowgrowing tree the northern pecan and butternut are coming more into favor.

Enemies: HICKORY BORER (*Cyllene pictus*) is a white grub ½ inch long, which bores in the trunk of the hickory. The beetle appears in June. It is a little over ½ inch in length, with long antennae, of a brownish color mottled with white. As soon as the burrows of this insect are detected the grubs may be cut out with a knife or killed by means of a flexible wire. The hickory is also subject to the attacks of other species of tree borers, various specimens of leaf-eating caterpillars, the hickory nut weevil and other insects.

LOGANBERRY

The loganberry is a chance cross between the California wild blackberry and a red raspberry originated in 1881. The fruit has characteristics of both parents. It is rich dark red in color and often 1½ inches long. Loganberry is eaten fresh or canned and is also dried in large quantities by the same method and apparatus as is used for drying prunes. For pies and juice it is a strong favorite. A good average yield is 4 tons per acre. Nearly all of the commercial crop is raised in the Pacific Coast States and ⅔ of it comes from the Willamette Valley, Oregon. Market demand for loganberries is increasing. The plant is propagated from hard wood stolons and from single-eye hard wood cuttings, and is usually trained on some form of trellis. Its culture is the same as for raspberry and blackberry.

MACADAMIA NUT (*Macadamia ternifolia*)

Macadamia nut, a tree indigenous to Australia, was introduced into Hawaii in 1892 and now occupies plantings of about 800 acres on the Islands of Oahu and Hawaii, comprising some 60,000 trees. In 1931 a factory was built for processing the macadamia as a roasted product for world trade. There are both smooth and rough shelled nuts. The trees begin to bear at 3 to 6 years of age. The nuts are of a rich flavor and highly palatable.

MANGO

The mango is a beautiful evergreen tree with dense foliage of leathery leaves, graceful panicles of small yellow or greenish flowers, and pendant clusters of fruit from 2 ounces to 3 pounds in weight. The mango has been called the apple of the tropics. Some 600 varieties occur in India. It was first planted in Florida on the keys. Grafted specimens of the Mulgoba mango were introduced in 1889. The varieties now grown in Florida mature fruit from May to September. The color of the fruit varies from green to yellow and from various peach tints to a magenta. In some varieties a mat of fibers extends from the seed through the pulp, while others may be readily eaten with a spoon. The esteem in which the mango is held depends upon whether one's experience is limited to the stringy, turpen-

tiny seedling or associated with memories of the delicate aroma and agreeable flavor of the standard varieties.

MEDITERRANEAN FRUIT FLY
(*Ceratitis capitata*)

The Mediterranean fruit fly has been known as a fruit pest for 125 years and has spread over the world till North America is the only large area uninfested. Few fruits are exempt from its attacks. In Hawaii, where it was first accidentally introduced about 1910, probably in fruit from Australia, it has been found in over 70 kinds of fruits and nuts. In a locality where the fly may live in so many sorts of cultivated and wild fruits there is little hope of exterminating it. Parasites are useful and are already quite effective in infested coffee plantings, but these parasites have too short an ovipositor to reach the fly maggots in deep-fleshed fruits. It has been found that the eggs and maggots cannot survive refrigeration for 2 weeks at a temperature of 33° F.

Naturally a strict quarantine was imposed to prevent the entrance of the fly into the mainland of the United States. But in April, 1931, the fly was found in Central Florida. Immediately a campaign of spraying, embargo on shipments from the infested area, destruction of suspected fruit and inspection was put in operation, and by cooperation of all concerned the pest was exterminated.

MEDLAR (*Mespilus Germanica*)

A dwarf tree or shrub 10 to 15 feet high, yielding a small austere fruit of the same name. The medlar is little grown in the United States, but is common in some parts of Europe. It is perfectly hardy in the Northern States and is reported as yielding well as far north as Agassiz in British Columbia. Botanically the medlar belongs to the same family as the apple. The tree will grow in any good soil with ordinary cultivation. Varieties are propagated by grafting on pear or quince roots or seedlings. Seed of the medlar usually requires 2 years to germinate and will not reproduce varieties true to name. The fruit does not ripen till late fall after frost comes. It is then packed and laid in a cool, dry place away from draughts of air until it becomes mellow. It has an acid flavor and is used for eating out of hand and for preserves.

MULBERRY (*Morus* spp.)

The mulberry is little grown in this country. The home demand for the fruit is small and the market demand still smaller. The fruit can be successfully grown on nearly all soils and the tree is very hardy both North and South. Some varieties possess considerable merit for ornamental planting, for hedges and for windbreaks. The mulberry furnishes leaf food for the silk worm.

Mulberries may be propagated by cuttings of the ripe wood or of roots. Nurserymen usually propagate improved varieties by grafting on Russian mulberry roots. Early spring grafting with entirely dormant cions is one of the must successful methods of grafting the mulberry. The mulberry tree grows to about the size of an apple tree, and in orchards should stand 20 to 32 feet apart. For home use 2 or 3 trees will be sufficient.

The fruit drops when ripe and may be gathered by shaking the trees and catching on sheets or grass. The fruit is soft and rather sweet, much relished by birds, and ripens through a period of 6 weeks or more. In some cases it may be desirable to plant a few mulberry trees to furnish fruit for birds and thus portect more valuable fruits.

Downing, Thorburn and Trowbridge are the varieties usually grown in the Northern States for fruit. Farther south Black Prussian and Hicks are more often grown. Hicks is a heavy bearer but the fruit is of inferior quality. The Russian mulberries are especially valuable for ornamental hedges in the Western prairie States, especially in cold regions, and for small ornamental trees. The Chinese varieties used for feeding silkworms belong to the species *M. alba* var. *multicaulis*. Most of our fruit bearing varieties also come from *M. alba* and the native *M. rubra*.

Silk Culture. The business of raising silkworms has never been developed to any great extent in the United States. Small attempts along this line have been made in California, Utah, Kansas and elsewhere. The majority of such enterprises have been abandoned on account of the high price of labor. It is possible that the work of feeding silkworms could be done by children at a very low price. Mulberries are already planted extensively in this country and it has been shown that osage orange equals mulberry as food for silkworms. There are thousands of miles of hedge composed or osage orange, and the tree grows wild from Missouri to Texas. The income from silk raising is not sufficient to warrant the ordinary farmer in engaging in the busi-

ness until further experiments have been made.

NECTARINE (*Prunus Persica nectarina*)

This is a smooth-skinned peach. It is inferior in quality to the peach and is little grown commercially except in California, and there only on a small scale, principally for drying and canning. It will grow wherever the peach will grow and is cultivated in exactly the same manner. Peach stock has been found desirable for nectarines in California on alkali soils.

There are but few cultivated varieties, the more prominent of which are Boston, Dawnton, Advance, Hardwick etc.

For enemies *see* under *Plum, Peach* and *Apple*.

OLIVE

The olive is one of the oldest of cultivated trees. Indigenous to Asia Minor it is grown chiefly around the Mediterranean along both shores from Turkey to Portugal and from Morocco to Palestine. It has been introduced into nearly all tropical and subtropical countries, but outside of the Mediterranean region, California and Arizona have the only commercial olive orchards. The tree lives to an extreme old age. There are specimens on the Mount of Olives and in the Garden of Gethsemane that are 2000 years old.

The olive is an evergreen tree with narrow, leathery leaves, small, white, fragrant flowers, and a round or ovate bluish-black fruit when ripe, ¾ to 1 inch in diameter. The tree will endure temperatures as low as 20° F. The fruit is borne on 2-year wood and never twice on the same wood. New wood must be produced every year. The U.S. olive crop is about 43,000 tons, practically all from California where the olive belt extends from Shasta to San Diego Counties with over a million bearing trees. Mission is the leading variety but Manzanillo, Sevillano and Ascolano are also popular, grown in 36 counties of California and 2 counties of Arizona.

Like most fruit trees, the olive prefers a well drained soil with low water table and without too much nitrogen. The familiar requirements for all other orchard fruits for water drainage and air drainage apply also to olives. Thus, low, flat lands as well as high mesas, must be avoided. Protection against high winds should be provided but moderate breezes at night may be helpful when the temperature approaches frost.

According to C. F. Kinman, "The olive may be propagated by seeds and cuttings or by budding or grafting. As seedlings do not come true to the variety and therefore do not produce a uniform type of fruit, they are grown only for stocks on which to bud or graft. By far the greatest portion of the olive orchards in the southwest United States have been grown from cuttings, and this method of propagation is still in use by most orchardists and nurserymen. The reasons given for preferring this method are that but little skill is required in making the cuttings and that the trees are more quickly and cheaply grown, at least to a size suitable for setting in the orchard, than budded trees. It is claimed by some that by budding or grafting a seedling stock, a tree superior to one grown from a cutting may be produced. The great number of orchards, which have given satisfaction when trees grown from cuttings were planted, allay the doubts of most planters, however, regarding the success of such trees.

"For making cuttings, soft tender tips of branches or older hardwood are used. Nurserymen who require a large quantity of olive trees for their trade and propagate them by cuttings often use the branch tips, as it is difficult and expensive to secure hardwood cuttings of suitable size in sufficient number. They are also usually equipped with the necessary lath houses or other suitable means for furnishing the shade and protection from wind required by the young cuttings and for keeping in proper condition the beds of sand in which the cuttings are placed. About 4 inches is the usual length for making softwood cuttings. The tips selected should be those that have completed their length growth and are becoming firm but are not too hard. The condition of the growth, therefore, rather than any particular period of time, determines when the cuttings should be made. When preparing a cutting for planting the cut is made just below the node (the region where a leaf occurs), the same as for other plants. The two lower leaves are then removed and the others cut back about one-half their length. The cuttings are then placed in the sand bed rather close together, where they remain until roots have started, which under favorable conditions is but a few weeks. They are then transplanted to nursery rows or beds, where they are

left until they are ready for planting in the orchard. It is claimed by some that trees thus grown have a better root system than those grown from large cuttings."

Transplanting of the young trees into the orchard is usually done March 1 to May 15, either 25 feet apart both ways or, where heavy growth is to be expected, 30 or 33 feet apart. Interplanting of olive orchards with peaches, apricots or plums is common practice. In order to keep the soil in good physical condition a cover crop of wild growth is encouraged in winter, or vetch and melilotus are sown for this purpose.

Ordinarily it is recommended that irrigation water be applied about every 30 days, or at least 2 or 3 weeks before the blossoms appear and again during the first half of September. Much difference of opinion prevails among olive growers as to whether fertilizers are required in olive orchards.

Pruning aims to create a tree form which facilitates harvesting operations and to admit light and thus favor new growth in all parts of the tree. Most growers cut back the young nursery trees before planting so as to induce the main branches to start about 2 feet above the ground.

A heavy crop requires 3 or 4 pickings. Gathering begins in September and, near the coast, may not be over till February.

Careful handling of olives intended for ripe pickling is important. Bruised fruit can be used for oil. The pickling process takes place in wooden or concrete vats in which the fruit is soaked in a caustic solution, washed in fresh water, then soaked a few days in salt water then sealed in cans. All ripe canned olives are subjected to a temperature of 240° F. for 1 hour.

Enemies: Knot or Tuberculosis (*Phytomonas savastonoi*) is characterized by the development of numerous knots or warts on the leaves, trunk and branches. On the leaves the knots are very small and mostly on the lower side. On the branches and trunk they vary in size, but may be 2 inches in diameter. The conditions favorable for disease are too much pruning, irrigation and hot weather. No buds or cuttings should be taken from infected orchards. Pruning shears should be disinfected so as not to carry the disease from tree to tree. The Mission variety is almost immune.

Dry Rot is recognized by the presence of black spots and cavities near the pit of the olive. The central portion becomes brown and dries up. The disease develops most rapidly after the olives are picked. It is recommended that the trees be kept free from scale insects and be sprayed with Bordeaux mixture. Olives are also attacked by scab, sooty mold and bacterial rot but these diseases are seldom serious. The chief insect enemy of the olive is the bark lice. *See scale insects* under *peach*.

Twig Borer (*Polycaon confertus*) bores into the smaller twigs at the base of the buds. Infested twigs may usually be recognized and should be cut off at pruning time and burned.

PAPAYA (*Carica papaya*)

Papaya is a spongy-textured, rapidly growing tree native to Central America and now grown in all parts of the tropics for its abundance of delicious fruits. In 12 to 15 months from seed it attains a height of 8 to 10 feet, and bears along the trunk a profusion of melon-like fruits from 2 to 20 pounds in weight. The leaves and fruit contain papain, an active digestive ferment. The Hawaiians for ages have wrapped meat in bruised papaya leaves to make it tender. The fruit is best eaten fresh with a dash of lemon or orange juice. Papaya is raised on a small scale in Florida, Texas and California. It is propagated by seed and may be planted in rows about 10 feet apart both ways.

The **Native Papaw** (*Asimina triloba*) is quite unrelated to the papaya. It is found from New Jersey and New York south to the Gulf and west to Texas. The fruit, 2 to 6 inches long, ripens from August to November. The pulp is white or yellowish, and contains several large black seeds embedded in it. The papaw may be cultivated but the fruit is ordinarily gathered from wild trees.

PEACH

Peaches are grown commercially in 30 states, and are, or could be a part, of the home garden plot in every State. The total yearly crop is nearly 70 million bushels, of which California produces over 22 million, mostly clingstones for canning. The leading peach States are California, Georgia, South Carolina, Arkansas, Michigan, North Carolina, Alabama and Illinois. But it would be a serious mistake to assume from this wide distribution that the peach can be grown successfully everywhere. The most important matter in starting an orchard of any kind of fruit is the selection of the site. Cali-

fornia and Georgia are famous for their peaches, but not every farm in California and Georgia is suited to peach growing. The peach tree demands good soil drainage. It cannot endure wet feet. A deep soil, and a not impervious subsoil, are first requisites, not along river bottoms but on land slightly elevated, on a slope, if necessary to get above the lowest level of the neighborhood. An elevation of a few feet provides for water drainage, and permits the cold air to flow down out of the orchard into the lower levels.

This provision of air drainage is of great importance for the reason that the peach is an early bloomer and is only too likely to be nipped by a late spring frost unless the site of the orchard has been wisely chosen.

The occurrence of frosts on low lands, even when higher lying areas escape, is a matter of common knowledge. Winter-killing is also more common in low lands than on slopes. The point of the compass toward which the slope faces is not always of prime importance. The peach growers in central Michigan select elevated lands and plant on northern and western slopes if possible. A steep southern slope may hasten the date of blooming quite noticeably, but on moderate slopes the difference in the time of the first blooms may not be a vital matter. The slope of the land on which a peach orchard is to be located may be so chosen as to protect the trees against the drying effect of the prevailing winds of the particular locality.

Large bodies of water exercise a more decided effect on local temperature than the slope or elevation of farm lands in the immediate vicinity. Water absorbs heat more slowly than soil and therefore has a cooling influence upon the air in early spring, thus retarding the blooming of fruit trees till danger of late frosts is past. By the same token early fall frosts are delayed. The water retains the heat of summer longer than the soil, cools off more slowly, and brings about a more gradual lowering of air temperature than would otherwise be the case.

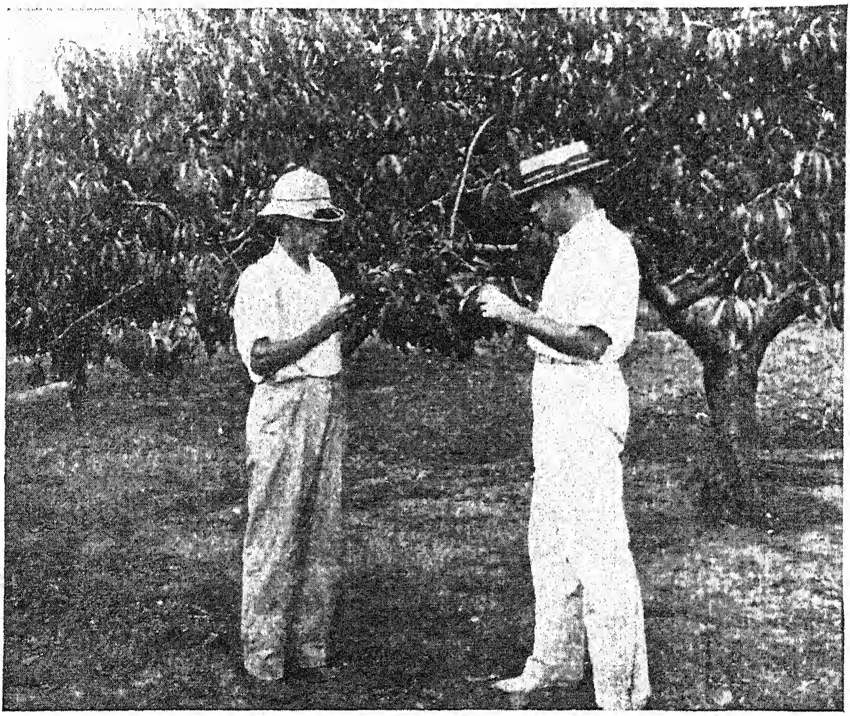
The best soil for the peach is a rich, well drained sandy loam, but peaches may be grown on almost any soil except heavy clays. In many localities gravelly loams seem to be satisfactory. Fairly good orchards are often seen on exceedingly stony land, provided drainage is good and fertility adequate.

PICKING PEACHES IN GEORGIA

Cultivation. For the first 2 or 3 years after the peach orchard is set out hoed crops, like beans, melons, etc., may be grown between the rows of trees and the trees kept cultivated, but after that the whole space should be given entirely to the trees. No grain crop should ever be grown in the orchard, nor should it ever be seeded down. In general the peach orchard should be plowed each spring and kept thoroughly cultivated during the summer up until about the first of August, when cultivation should stop, and some cover crop be sown. Cultivation is stopped in August and a cover crop sown in order to check growth, ripen up the wood of the tree and lessen the danger from winter injury. When the cover crop is turned under in the spring it adds considerable humus to the soil, and if a leguminous crop like crimson clover, hairy vetch or peas has been used it adds nitrogen to the soil.

Fertilizers. Potash and phosphoric acid are the most important fertilizers for the peach. Nitrogen is of less importance. If leguminous cover crops are grown in the orchard these will supply all the nitrogen necessary on ordinary soils. On light soils a dressing of 25 tons of well-rotted stable manure applied every other year will make up for any deficiency of nitrogen. So long as the trees make a good growth each season and the leaves have a deep green color the trees are not suffering for nitrogen. If the barnyard manure is supplemented with 100 bushels of unleached hardwood ashes the peach orchard will be fairly provided with plant food. If commercial fertilizers are used a bearing orchard will require every 2 years from 300 to 500 pounds ground bone, 200 to 300 pounds muriate of potash, and on light soils 150 pounds nitrate of soda.

But lack of plant food may not be the reason for the unthrifty appearance of an orchard. It may be due to poor physical condition of the soil, lack of humus, too much seepage water or some unrecognized disease. Moreover the soil may lack potash only or phosphorus only and may already contain too much nitrogen. There is no fertilizer panacea for all plant ills. Each orchard requires individual treatment and the best remedy can be found only by experiment, using different fer-



BEARING PEACH ORCHARD

tilizer formulas until the right combination is hit upon.

In Georgia, E. F. Savage made a study of the factors which affect the longevity of peach trees, during which the life histories of over 40,000 were followed in 3 sections of the Georgia peach belt. In all sections winter injury, either crown injury or sunscald, was found to be the chief cause of the premature death of peach trees. Sunscald is occasioned by high temperature during sunny winter days followed by sudden drops to freezing temperatures at night. The damage was far greater on southwest than on northeast slopes, 95 per cent of the trees on northeast slopes being in good condition as contrasted with 34 per cent on the southwest slopes. Soil erosion may greatly shorten the life of peach trees. On steep slopes in Georgia erosion may carry away so much of the topsoil into which the roots penetrate most easily, as to cause starvation from inadequate soil volume in which the roots may find plant food. A 10 per cent slope results in much greater erosion than one of 5 per cent. On a 10 per cent slope the trees die young unless special attention is given to protection against erosion.

Pruning. At the end of the first season in the orchard the young trees will have sent out many branches. Early the following spring 4 or 5 of the strongest of these which come out at different points around the stem should be chosen to form the head and the remainder removed. If the branches come out at different points there is less danger of the limbs splitting down later when they become loaded with fruit. The head should be started low, 2 to 2½ feet from the ground. The branches selected for the head should be cut back about half their length. The leader should be a strong upright-growing branch and left a little longer than the others so that other side branches may be sent out from it. Subsequent pruning will consist largely in heading in the annual growth, and removing dead or undesirable branches. In this connection it is well to remember that fruit is borne one season on wood that was made the preceding season, so if the winter has been severe and only a few scattering buds are alive, only the ends should be slightly headed in; but if all the buds are alive the spring pruning should consist in removing one-half or two-thirds of the growth of the preceding summer. In this way the tree is kept in a low compact form from year to year so that most of the fruit can be gathered while standing on the ground, and the work of thinning and spraying is greatly reduced.

Thinning the Fruit. If left to themselves many varieties of peaches set more fruit than they can properly mature. This weakens the tree, tends to the production of crops only in alternate years, and the fruit is inferior in size and marketableness and more subject to rot. The best growers thin the fruit and are well repaid for it in the larger size of fruit and better prices received. Thinning should be done just before the pits begin to harden, or when the fruit is as large as the end of the thumb, in June or July. The poorer or diseased fruits should be removed first. If the limbs have not been headed back the peaches should be thinned to 6 inches apart; but if the fruit has been partially thinned by heading back at the spring pruning, the fruits may be left closer together than this. One grower states that 800 peaches is sufficient for 1 tree to mature.

Winter Protection of Peaches. In many sections where the climate is unfavorable to peach production, successful crops are grown by protecting the trees over winter either from severe cold or the various climatic changes. The Missouri Experiment Station found that if peach trees were thoroughly sprayed with whitewash in the fall the trees absorbed less heat on sunny days during the winter, the buds remained practically dormant, while buds on untreated trees swelled preceptibly during warm days in February and March, and they blossomed 3 to 6 days later than trees that had not been whitewashed. Other trees at the same station, when shaded from the sun during the winter with boards, produced a full crop of buds, while 80 per cent of the buds on exposed trees were killed. This latter method of winter protection is too expensive except on a small scale.

Propagation. Peaches are propagated from seed and the seedlings budded with the improved varieties. A few varieties come practically true from seed and do not require budding. The seed is gathered and stratified with sand in the fall and exposed to the action of frost over winter. The following spring they are planted in the nursery 6 to 8 inches apart in rows wide enough to admit horse cultivation and covered about 2 inches deep. In August or September trees in the North will be ready for budding. Use well-matured buds and bud close to the ground, according to the method de-

scribed under *Grafting*. Fall-set buds remain dormant over winter and start into growth the following spring. In the fall the trees will be ready to transplant into the permanent orchard. Such trees are known as 1-year-old stock and are the best for setting in the orchard. In the South trees are also budded in June. Small growers should buy their stock from a reliable nurseryman rather than attempt to grow it.

Planting. In the permanent orchard the trees should stand 18 feet apart each way. Strong growing varieties on heavy soil are set farther apart than small growing varieties on lighter soils. Spring setting is generally recommended. In setting the trees broken and injured roots should be cut off and the hole dug wide enough so that the roots will not be cramped. In Southern States some growers prune all the roots back to stubs less than 2 inches long and secure very good results, but this method has not proved generally satisfactory elsewhere. The trees should be set a little deeper than they stood in the nursery row.

As with other orchard fruits, there is a large number of peach varieties, early, late, white fleshed or yellow, cling stone or free stone. For the home garden in the Central and Middle Atlantic States Golden Jubilee, Halehaven and Elberta are highly recommended. In the commercial peach areas varieties for new plantings should be chosen by consultation with established growers and the horticulturist of the State Experiment Station.

Enemies: Brown Rot (*Sclerotinia fructicola*) is the common rot of peaches and other stone fruits. It appears first as brown specks which spread rapidly soon involving the flesh of the peach which shrinks into a dry brown mummy. The disease may also attack the leaves and blossoms.

Scab (*Cladosporium carpophilum*) attacks late varieties most severely, appearing as small black spots which soon run together causing the fruit to crack open. Scab may appear also on the under surface of the leaves. Removal and burning of mummied fruits, cankers, scabby leaves and dead twigs from infected trees will reduce some of the sources of infection, but the best means for controlling brown rot and scab is found in the application of sprays or dusts. The schedule of treatment recommended by the Department of Agriculture for the eastern half of the country, except Georgia and the Gulf States, is about as follows: While the calyces are falling spray with arsenate of lead (1 pound to 4 pounds hydrated lime in 50 gallons of water) or dust with sulphur, arsenate of lead and hydrated lime. Two weeks later dust with the sulphur, arsenate of lead and lime mixture. One month before harvest dust with a mixture of 80 per cent sulphur and 20 per cent hydrated lime.

Borer (*Sannina exitiosa*) is a slender blue moth which resembles a wasp. The eggs are laid in the wood of peach, apple, plum and cherry near the ground. The young larvae bore in the sapwood and cause an exudation of gum from the holes in the bark. The insect lives 1 year in the wood, at the end of which time it reappears as a moth. Numerous remedies have been recommended for the destruction of this insect. A large number of them are dangerous to the trees and still others are practically useless. According to recent experiments in New York, the most effective remedies are mounding or throwing up earth around the trunks of the trees, the use of tarred paper or tobacco stems about the trunks of the trees, digging out the larvae, and an application of gas tar.

Twig Borer (*Anarsia lineatella*) is a moth with gray forewings, marked with brownish-black. The hind wings are of a darker color. The caterpillar is nearly transparent and pink in color. This insect destroys the terminal and sometimes the lateral leaf buds by eating them off at the base from its burrows in the twigs. Infested twigs usually do not fall off, although completely severed, but are held in place by a gummy substance. All infested twigs should be removed and burned.

Scale Insects and Mealy Bugs. These terms are commonly used to denote the various insects which are included under the term *Coccidae,* including *Aleurodes*. The family includes a considerable number of species which differ greatly in appearance and habits. The sexes of these insects are totally unlike, the males having 2 wings and the females being wingless, grub-like creatures, of a small size. The body of the adult female is usually scale-like or gall-like in form and is covered with a waxy or powdery secretion. The armored bark lice include a number of so-called scale insects which are protected by a shield-like cover. The shield or scale is partly secreted by the body and partly formed by the plant tissues. It finally becomes more or less

completely separated from the body, covering the whole insect and in the case of the female the eggs also. Another subfamily of scale insects are known as naked bark lice, from the fact that in this group no separate scale or covering is secreted by the insect. The female lays her eggs upon the bark and the young crawl about for a short time, after which they attach themselves to the bark by inserting the beak and remain in this position. In the armored insects the secretion of the scale begins as soon as the young lice become fixed to position. The young lice are therefore unprotected only during a short period of their existence. The term mealy bug is used to denote a number of insects belonging to the same general group, which are characterized especially by the development of a powdery or hairy secretion on the body and wings.

Scale insects attack all kinds of plants, including grasses, but are especially injurious to fruit trees. The more common injurious species in the United States are San Jose scale, oyster shell bark louse, scurfy scale, greedy scale, English walnut scale, peach scale, peach lecanium, New York plum scale and cottony cushion scale.

Scale insects are subject to attacks of a number of natural enemies, included under parasitic and predaceous insects, fungous diseases and birds. These natural enemies are usually sufficient to hold the species somewhat in check, with the exception of certain ones such as the San Jose scale, which has become one of the most important of orchard insects. The artificial remedies which have proved most successful in combating scale insects are fumigation with hydrocyanic-acid gas, spraying with crude petroleum or kerosene either undiluted or mixed with water, spraying with various soap solutions and with lime, salt and sulphur wash. The last named insecticide is popular in California and all States infested with San Jose scale. All scale insects may be treated by the same method after it has been determined by experience which process is most effective in any particular locality.

The most extensive experiments with remedies have been made in combating the San Jose scale. The results obtained from these experiments are usually applicable to other scale insects. The scale of the female San Jose scale is nearly circular in outline and somewhat larger than that of the male. The scale of the male is nearly twice as long as wide and is darker than that of the female, being sometimes black. The female scale is gray with the exception of a central area which varies from pale to reddish yellow. The scales are of a small size, being about 1/10 of an inch in diameter. In the Eastern States the best success has attended the use of resin wash and the lime, salt and sulphur wash, which are also very effective on the Western coast. The most convenient and successful method for treating nursery stock and small trees, where the expense is not too great, is by fumigation with hydrocyanic-acid gas. The same method has also been tested on a large scale in orchards, first in California and later in the Eastern States. When this method is thoroughly applied all scales are destroyed and there is little danger of injury to the trees.

NEMATODES. Nematode is the name applied to a large group of round worms, most of which are parasitic in animals or plants. A group of nematodes known as eel worms is of considerable economic importance, on account of the habits of this family in attacking the roots of various plants, causing the formation of knots or galls. These nematodes vary considerably in size, but as a rule are exceedingly slender and tapering at either end. A considerable variety of eel worms have been observed injuring cultivated plants in different countries, but in the United States one species, *Heterodera radicicola*, is the most injurious. Plants attacked by this species are covered with swellings or galls on the roots. The swellings are sometimes spherical, but vary exceedingly in size and are often irregular in shape. These galls occur on a great variety of plants, including garden vegetables, greenhouse plants, and fruit and shade trees In badly infested soil plants may be killed outright. Tomato and cucumber seedlings often suffer severely from the attacks of eel worms. Eel worms are not the only cause of swellings on the roots of cultivated plants. For a discussion of clubroot of cabbage *see* under *Cabbage*. The small tubercles which are found on the roots of various legumes are usually due to a bacterial organism which is concerned in the fixing of free nitrogen. The root tubercles produced by the woolly aphis may usually be recognized by the presence of the aphis. For crown gall, which is caused by a fungous parasite *see* under *Apple*. In galls produced by nematode worms an examination of the internal structure reveals the presence at least of female worms.

The young worms in coming into soil from affected plants, search for suitable roots to attack. They force their way into the root and thus set up an irritation which causes an abnormal growth of the root tissue. The worm increases in length and takes on a spindle and later a club shape. The females are larger and become readily visible to the naked eye. Various chemical insecticides have been tried in combating the attacks of these worms, but without striking success. Solutions of the insecticide capable of killing the adult worms are usually injurious to the infested plants. In greenhouses the most successful method of combating eelworms consists in heating the soil by means of steam or otherwise, to a temperature of 180 to 212 degrees F. A temperature of 140 degrees F. will kill the nematodes, but higher temperatures should be used in order to be certain that all the worms are destroyed. The various species of Heterodera which are especially injurious to garden vegetables and greenhouse plants are rather susceptible to the influence of extreme cold and are usually unable to survive the severe winters.

In the case of knot disease of fruit and shade trees, caused by eel worms proper drainage of the soil, rotation of crops, and burning all stumps and infested roots which may have been removed from the soil, is usually sufficient to protect the crops against the serious attacks of nematodes. In combating the nematode worms which attack coffee and similar crops in tropical countries the use of the remedies already mentioned and bisulphid of carbon injected into the soil, have given fairly satisfactory results.

CURCULIO. *See* under *Plum.*

The peach is also attacked by tent caterpillars (*see* under *Apple*) and many other species of minor importance.

PEAR

The production of pear is shifting steadily to the Pacific coast. Out of a total crop of 31 million bushels California, Washington and Oregon supply 20 million. Michigan and New York come next with something more than a million bushels each, while the remaining 8 millions come from the other 35 commercial pear producing States. The Pacific coast furnishes conditions under which the pear reaches a high degree of perfection of size, form, color and flavor. Dry sunshiny weather in summer seems to help in the control of pear blight, a disease which discourages the growing of superior varieties of pears in the rest of the country. The varieties chiefly grown on the Pacific coast are Bartlett, Anjou, Bosc and Winter Nelis. Bartlett leads in all pear districts of the Pacific States except in

PEAR ORCHARD IN OREGON

the Rogue River and Hood River Valleys. The Anjou and Bosc are more popular in Washington and Oregon than in California.

On the Pacific coast the pear extends from central California to British Columbia in Canada. Pear trees endure a winter temperature of 20 degrees below zero, and like the apple, require a period of sufficiently cold weather to bring about a resting stage. Irrigation is the rule in pear orchards in all the far western regions except along the coast of Oregon and Washington, where normal rainfall is adequate. The pear is an early bloomer and is as sensitive to frost as is the apple. Most Pacific pear orchards may require the use of heaters unless quite favorably located. Pear blight is more serious in the hot interior valleys than in the cooler coastal regions.

The Bartlett and Bosc appear to develop their high flavor where high temperatures prevail during the 2 months before harvest. But the Anjou and Winter Nelis are equally well flavored whether grown inland or along the coast. According to C. F. Kinman, while a fertile clay loam with a well drained subsoil is thought best for pears, the tree will thrive on heavier sticky clays and adobes better than most orchard fruits. Soil drainage is essential, and the water table must not be too high.

The preferred stock for propagating pear orchards is the European wild pear. Oriental stocks are also in favor and recently a variety known as Old Home has proved quite resistant to blight and is a promising stock for wide ultilization.

Irrigation tests have been carried forward for many years in various districts of California. In one Bartlett orchard 45 years old planted 20 feet apart the top 6 feet of soil was a clay loam and the next 6 feet rather sandy. Other orchards of different age were also drawn upon for interpretation of the effects of irrigation. It was found that pear trees growing on soil at least 6 feet deep may be kept supplied with readily available water by 2 irrigations before harvest.

BARTLETT PEARS IN OREGON

In the Yakima, Wenatchee and Hood River regions where water for irrigation is abundant, pear orchards may be kept permanently in a cover crop, such as alfalfa or sweet clover. The crop is allowed to grow the whole season, but is usually disked in the spring to prevent the cover crop competing unduly for water during the bloom period. Sweet clover seems to be better than alfalfa for this purpose. Where the water supply is limited the land is cultivated during the summer and

the cover crop allowed to grow in fall and winter.

Artificial manuring of pear orchards on the Pacific coast is not everywhere considered profitable, but wherever fertilizer seems required the best results have followed the application of high nitrogen carriers, once per season and usually in the fall.

In the Sacramento Valley large pear orchards planted exclusively to the Bartlett variety without planning for cross pollination have yielded good crops year after year. But many growers contend that maximum crops cannot be had without crossing. This may be accomplished by planting different varieties in alternate rows, or by planting a good pollenizer every 3rd or 4th row, or by topworking an occasional tree to a pollenizer. The Bartlett may be used as a pollenizer for any of the other varieties.

In Eastern States where blight is such a serious menace to nearly all varieties of pear except the Kiefer, many experiments have been aimed at the discovery of a method of rendering the grit cells of this variety less objectionable. The Department of Agriculture has found that Kiefer pear may be picked at any stage from the time it is half grown till it has reached full size and that by placing it in cold storage at 60° F. for 2 or 3 weeks the "fruit becomes uniformly soft and it proves quite satisfactory for eating or cooking. Kiefer pears to be handled in this manner should be carefully hand picked in order to avoid bruising."

Statistics furnished by canneries for the Yakima and Wenatchee districts of Washington indicate that in an average crop of 55,500 tons of Bartletts, 39,850 tons are canned. Bartletts held for 15 to 30 days in cold storage before canning showed an improved color and texture from this treatment.

Pruning. Pear trees should be headed out 16 to 18 inches from the ground. Pruning to a vase form, while requiring more skill in the beginning, produces trees easy to work around and to prune, thin and harvest the fruit. The head should be started with 3 main branches coming out from different places on the trunk. Standard trees should be continually headed back to about 18 inches of annual growth. The tree naturally grows in a pyramidal form and when thus grown requires little pruning other than an annual thinning out. Winter and early spring is the usual period for pruning pears. The fruit of the pear is borne on spurs which continue to branch and fruit for several years.

Thinning. Pears are thinned perhaps more than other fruit. This practice prevents the trees from overbearing, improves the quality, size and marketableness of the fruit and tends to the production of annual crops. It pays. Thinning may be carried far enough for a ratio of one fruit to 30 or 40 leaves. Of course all wormy and inferior fruit is thinned out first.

Harvesting. Unlike most fruits the pear is improved in quality by picking some time before it is ripe and then ripened up in a close room or packed in boxes and allowed to ripen. They should be picked by hand. When the pears have reached full size and a very slight color begins to show they should be gathered. They mellow and color up beautifully in storage, but should not be kept where the air will blow over them or they shrivel up more or less. Pears are usually packed for market direct from the tree. They keep best in cold storage at a temperature of 32° F. From 80 to 100 barrels of pears per acre is a fair yield. The life of a standard orchard varies from 25 to 50 years and of a dwarf orchard somewhat less.

Dwarf Pears. Pears grown on quince roots are much dwarfed in size. They come into bearing earlier than standard trees, are very productive and the quality of such varieties as Angouleme is greatly improved. Dwarf trees require more pruning than standards and should not be grown higher than 12 feet. In setting the trees in the orchard the point of union should be 5 or 6 inches below the surface of the ground. This places the quince roots beyond the reach of borers. The following varieties are oftenest grown as dwarfs: Duchess, Louise Bonne, Anjou, Clairgeau, Bartlett, Seckel, and sometimes Kiefer.

Enemies: Fire Blight (*Bacillus amylovorus*) appears in the spring on the blossoms. Some flower clusters turn black and the disease is carried from flower to flower by bees and other insects. From the flowers the disease spreads to the leaves and twigs. The leaves turn a uniform brown color and sunken areas appear on the twigs. "Blossom blight" and "twig blight" are different forms of the same disease. The only treatment for this trouble is of a preventive nature. Trees should be kept in good vigorous condition by cultivation and fertilization

and all blighted parts should be cut out as soon as observed.

LEAF BLIGHT (*Entomosporium maculatum*) attacks pears and quinces, affecting the fruit, stems and leaves. The disease appears with the first appearance of the leaves or later, if the season is dry. Small brown spots appear on the leaves, increase in size and finally run together. The leaves fall prematurely. On the fruit the spots are red, and later turn black. The quince is affected in the same way, except that the leaves may turn yellow before falling. The Duchess and Kiefer varieties are somewhat resistant. In orchards the disease may be controlled by several applications of Bordeaux mixture, beginning when the leaves are nearly full grown.

SCAB (*Fusicladium pirinum*) appears as brown spots on the leaves or fruit. Affected fruit usually cracks open. The disease is very similar to apple scab and may be checked by spraying with Bordeaux mixture before flowering, after the blossoms fall, and a third time about 2 weeks later.

LEAF SPOT (*Septoria piricola*) closely resembles leaf blight, but the spots are larger and more distinct. The center of the spots is gray, with minute black specks. The gray shades into brown and purple on the edge of the spots. The disease may be held in check by 3 applications of Bordeaux mixture at intervals of 2 weeks, beginning just after the petals fall.

CANKER. *See* under *Apple.*

BLISTER MITE (*Phytoptus pyri*) is a small mite barely visible to the naked eye, of a white color. The eggs are deposited in spring and the mites on hatching make their way to the young leaves, where they cause the formation of galls, in which they live during the summer. In the fall the mites leave these galls and migrate to the winter buds, in the scales of which they pass the winter. Infested leaves show red spots or blisters, which change to green and later to a brown color. Such leaves should be removed and destroyed, and the trees should be sprayed with lime sulphur.

MIDGE (*Diplosis pyrivora*) is a fly resembling the mosquito, which appears just before the flowering time, pierces the flower bud and lays its eggs on the stamens. The maggots on hatching penetrate into the core of the young pear. The maggots become mature in June and drop from the deformed pears to the ground. The winter is passed in the chrysalis stage. Infested pears have a knotty, irregular shape and drop from the trees prematurely. The Lawrence and Bartlett are most attacked. The ground underneath pear trees should be thoroughly cultivated and rolled not later than the last week in May, and kainit should be applied at the rate of 1000 pounds per acre, for the purpose of destroying the chrysalis in the soil.

PSYLLA (*P. pyricola*) is a minute insect resembling a cicada in appearance. The immature form is of a yellowish color and the adult is nearly black. The adults of the first brood appear about June 1, and those of the second brood about a month later. The immature form of the insect may be readily killed by spraying with kerosene emulsion in early spring, just after the leaves have unfolded.

BORER (*Sesia pyri*) is a moth resembling the peach tree borer and often mistaken for a wasp. The eggs are laid upon the bark of the trunk or lower branches, and the larva makes its way into the sapwood, where it lives for about a year. Warts or black swellings appear upon infested branches, and sometimes several larvae may be found in a single swelling. The larvae may be dug out with a knife, while the swellings may be treated with kerosene.

FRUIT TREE BARK BEETLE (*Scolytus rugulosus*) is a small cylindrical beetle 1/10 of an inch long, black in color, which emerges in March and eats small holes through the bark. After penetrating through the wood, burrows are made lengthwise of the tree, and in these tunnels the eggs are deposited and the young grubs form small tunnels at right angles to the original ones. There are 4 or more generations annually, and the beetle feeds on all the common deciduous fruit trees. Trees should be kept in vigorous condition in order to withstand the attacks of this beetle. A wash containing 1 pound of potash whale-oil soap to 2 gallons of water, applied in March and again in April, will prevent some of the beetles from boring into the trees.

TWIG GIRDLER (*Oncideres cingulatus*) is a brown or gray beetle, 1/2 inch in length, with long antennae. There is a conspicuous gray brand on the back. Eggs are deposited in the fall near the end of twigs below each bud. The twig is then girdled between the egg and the trunk. Such twigs fall off and the larvae continue to develop in them. Fallen twigs should be collected and burned before the insects escape. No other prac-

tical remedy has been devised. The insect attacks various other fruit trees as well as the pear.

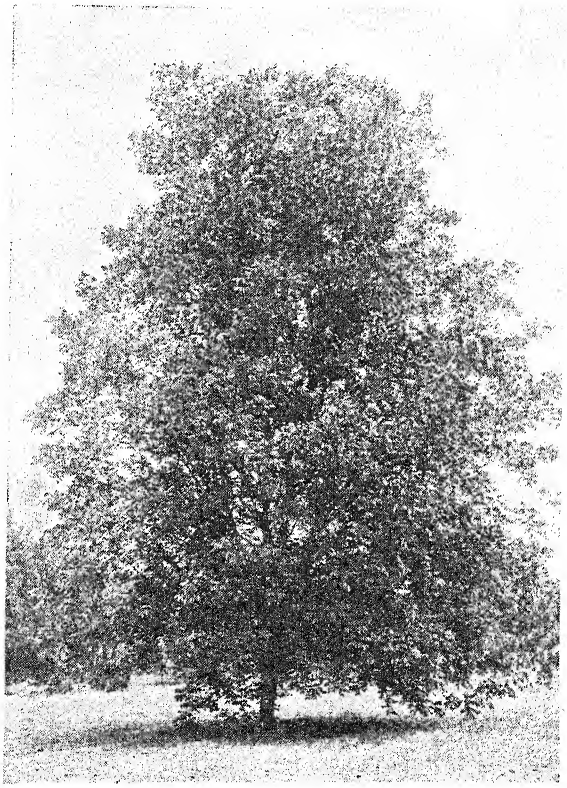
PECAN (*Hicoria pecan*)

This nut tree belongs to the hickory genus. It grows wild in rich river bottoms from Iowa and Kentucky south to Louisiana and west to Texas. It is probably the most important native nut tree in America. Most of the pecans of commerce are gathered from wild trees, but commercial pecan orchards are being planted in many Southern, Central and Southwestern States and California.

The total commercial crop is 86 million pounds of which 60 million pounds come from seedlings. Pecan orcharding is mostly confined to the Atlantic Coast and Gulf States from Virginia to Texas, the leading States being Oklahoma, Texas, Georgia, Mississippi and Arkansas. There are about 11 million pecan trees in bearing.

The pecan tree when fully matured is one of the monarchs of the forest. It grows from 90 to 175 feet high and has a majestic dome-like top. In leaf appearance it resembles the common shagbark hickory. The nuts are generally oblong in shape and vary in size from 25 to 100 nuts per pound.

Propagation. The tree is propagated from seed. The nuts may be either stratified in moist sand in the fall and planted out in the spring, or planted out in the fall soon after they are gathered. The latter is the better method unless mice and other rodents are too abundant. The nuts should be planted 3 inches deep in well-prepared nursery soil, placing the nuts side down and about 3 inches apart in rows 2½ feet apart. During the growing season they should receive the same fertilizers and cultivation as are usually given to orchard trees. The trees will be ready to set in the permanent orchard in 2 years. When the trees are grown from seed only about 50 per cent come true to the parent form. Many growers are



PECAN TREE

therefore budding or grafting the improved varieties on seedling stock. As with all hickories, this is a rather difficult process. Annular and veneer shield budding or cleft and whip grafting (*see Grafting*) have proved the most desirable methods of budding and grafting these trees so far. The graft should be made at the crown and close to the ground. If the stock is small enough the whip graft should be employed, but if 2 or 3 inches in diameter a side cleft graft is better. The cion should have 3 buds, and preferably a terminal one. The graft should be held in place by pressing moist clay about it or with grafting wax. Dirt should then be drawn up around it. Grafted or budded stock should remain one year longer in the nursery than seedling stock. Recent experiments have showed the advantages of an inlay-bark graft over all other methods. As covering for the grafts a wax composed of 10 parts rosin, 2 parts beeswax, and 1 part talc gave best results in percentage of good unions.

Soil. On very rich soils pecan trees tend to grow wood rather than nuts. One writer in Georgia states that sandy loam soil with a clay subsoil has given excellent results with him. In general land suited to the culture of corn and cotton will give good results with pecans. Nearly all seedling pecans are grown in river bottom land which is the natural habitat of the tree. But nearly all the plantings of improved varieties are on upland soil.

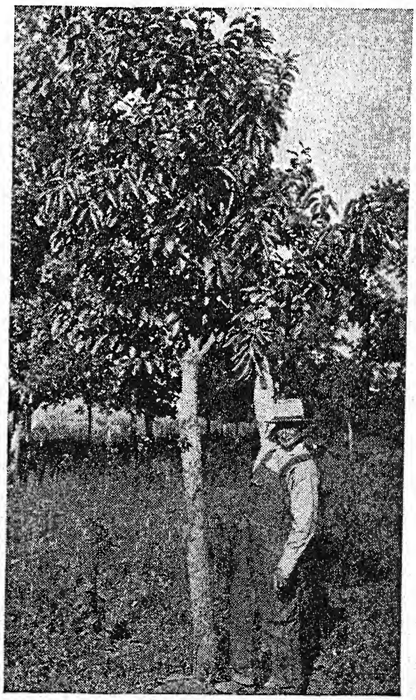
Planting. The trees in the orchard should stand about 40 feet apart on the poorer soils and 50 to 60 on the richer bottom lands. The pecan has a very long tap root. At transplanting time this should be shortened back to about 18 inches from the crown and all injured roots removed. The Florida Station recommends root pruning in the nursery row. This practice it is thought favors the development of more lateral roots. Pruning the tops of 1- or 2-year old trees set in the orchard is not considered advisable, as it tends to the development of shoots. The pruning necessary for the pecan is confined largely to the formation of the head. This should be started 3 or 4 feet from the ground and the center limbs cut back to induce lateral branches and a rounded form. The pecan orchard will require about the same cultivation as fruit orchards. Pecan trees may bear a few nuts at an early age, but paying crops cannot be expected under 10 years and full crops under 20.

Varieties. By selection and cultivation a number of varieties of pecans have been originated which are great improvements over the native sorts. Thin shelled varieties, other factors being equal, are most desirable. Frotscher is one of the largest and best pecans and has a thin shell. Century is one of the largest varieties, the nuts running about 25 to the pound. Other excellent sorts are Stuart, Van Deman, Paragon, etc. Native trees that produce inferior nuts have been successfully top-grafted with improved varieties in the Gulf States.

PERSIMMON

The native persimmon (*Diospyros Virginiana*) grows wild in the southeastern quarter of the U.S. with occasional groves in Iowa, Nebraska, Connecticut, Rhode Island, New York and Michigan. The tree attains a height of 60 feet with a diameter of 2 or 3 feet, but is usually less than 40 feet high.

The green or partly ripe fruit is very puckery to the taste, but loses much of this on ripening, becoming sugary and very edible. It varies from ½ to 2 inches in diameter and assumes various forms, but in general resembles a crab apple.



PERSIMMON TREE

Each fruit usually contains from 4 to 8 rather large, flat seeds. The fruit ripens from August to December. Frost seems to aid in the ripening of some varieties while others mature before frost comes.

Propagation. Some attention is being paid to the culture of native persimmons. They are usually propagated from seed. The seedlings do not come true to the parent type, however, any more than apple seeds do, and budding and grafting the seedlings with improved varieties is therefore resorted to. The seed is stratified in moist sand over winter and planted out in the spring. The seedlings remain in the nursery 1 or 2 years and are budded or crown grafted in the spring, when the bark slips freely. Transplanting is best done in autumn. As much of the tap root should be preserved as possible, otherwise the tree is very difficult to transplant successfully. It thrives best on soil suited to the plum or peach. Valuable orchards can often be quickly grown by top-working old native trees with improved varieties. In this work the cions must be inserted in vigorous growing branches. It is claimed that the persimmon is as easily grafted as the apple. An improved tree will yield from 2 to 3 bushels of fruit annually. Some of the more important native varieties that have arisen are Josephine, Ruby and Early Golden.

Japanese Persimmons. The Japanese persimmon has been grown in this country about 65 years. The fruit is much larger and more attractive in appearance than the native persimmon. The trees are smaller and the same variations in the form, quality and ripening period of the fruit occur as in the native plant. These persimmons are grown mostly on native American stocks and on top-grafted native trees.

Use. Persimmons are usually consumed in the fresh state. They keep remarkably well, and when stored in a cool place preserve their freshness for weeks. The Hachiya variety is often preserved by drying. Persimmons may be preserved by packing with sugar in a tight jar, or placing in a can and pouring over them a syrup made of white sugar and water. It is not necessary to heat the fruit before canning.

According to W. F. Fletcher, "Until a few years ago the native persimmon and its fruit were singularly free from fungus and other diseases, but in 1937 a new disease was found that threatens the existence of the persimmons in the Southern States. It is a wilt caused by *Cephalosporium* and has already been observed in Tennessee, Mississippi, Alabama, Georgia, Florida the Carolinas and Texas. In some areas it has killed more than 90 per cent of the trees. It is characterized by brownish black streaks in the wood and by a sudden wilting of the leaves. The Asiatic persimmons are highly resistant to the disease."

Heretofore about 2 million board feet annually have been used in the manufacture of wood products, about ¾ of it for golf-club heads, and nearly all the remainder for shuttles used in the textile industry. In order to check the wilt disease it is urged that all sick or wilting trees be at once removed and burned. It is desirable also to gather and burn all twigs which fall as a result of the egg-laying habits of the twig girdler (*Oncideres cingulata*). These twigs contain larvae of the girdler and should be picked up and burned in June or early July.

PINEAPPLE (*Ananas sativa*)

The pineapple is the most conspicuous of the few fruits that do not develop their full flavor if picked when green. In the stage in which they are commonly picked for shipment as fresh fruit, the pineapple contains about 4 per cent of sugar, whereas when fully ripe it contains 9 to 14 per cent of sugar with an average of 11 per cent. The stump of the pineapple is a thick starchy root stock. The supply of sugar for the ripening fruit is obtained by the transformation of the starch in the stump into sugar. There is no material in the fruit that can be transformed into sugar. Pineapple picked green may develop the color of mature fruits and soften but the sugar content remains the same as when picked.

The pineapple is apparently a cultivated form of a wild species that grows abundantly in the forests and along roadsides in Paraguay and Brazil. As a cultivated crop it is grown on a large scale in South America, West Indies, Porto Rico, Cuba, Florida, Hawaii, Malay States, Ceylon, Java, Queensland and other parts of the tropics and subtropics.

The scientific and practical problems of pineapple culture have been most thoroughly studied in Hawaii where some 50,000 acres are devoted to this crop. The plant is a herbaceous perennial, 2 to 4 feet high, with a short stem or stump from the base of which long fibrous roots develop. Along the upper part of the stump, arranged in a spiral fashion, are the long, narrow, and usually spiny leaves.

At blossoming time a spike of small lavender flowers appear, developing into a conical fruit 1 to 15 pounds or more in weight.

The plant is propagated by suckers which arise in the axils of the leaves below the fruit stem, or from slips which grow just at the base of the fruit, or from the crown of the fruit, or even from the stump. If suckers are taken for planting the resulting plants will mature fruit within 15 to 18 months. A longer time is required if crowns or slips are used. In Hawaii the first crop is followed by a rattoon crop after which the land is plowed, planted to a cover crop, replowed and again set to pineapple suckers, the whole cycle occupying about 5 years. Whether suckers, slips or crowns are used for new plantings, a few basal leaves are pulled off exposing the base of the suckers to callus before being set out.

On account of the long stiff leaves which lean into the space between the rows, it is difficult to cultivate the fields without injuring the leaves. But about 20 years ago the growers began using a specially prepared paper for mulch. This paper comes in 600 foot lengths in rolls like news print paper, and wide enough, 36 to 58 inches, to permit 2 lines of suckers to be set in it, side by side in rows sometimes a mile long. Thus the paper mulch covers the soil between each 2 rows and is allowed to remain for the whole period of the main and rattoon crops. By the use of this paper mulch it has been found that the plant food in the soil was held in a more available form, the moisture content of the soil was kept more uniform, soil temperature better regulated, weeds in the rows entirely eliminated, and yields increased 25 per cent.

PINEAPPLE FIELD IN HAWAII

In Florida the soil on which pineapples grow best is a fine sand which is exceedingly poor in plant food. "Hickory scrub" land is considered the best by Florida growers. This consists of an upper layer of 5 or 6 inches of fine white sand analyzing 94 to 99 per cent pure sand, and is underlaid by a yellowish sand. Pineapples have been successfully grown on many other lands. One of the essential factors of a good soil seems to be thorough drainage. The crop withstands drouth well, but succumbs to an excess of water in the soil.

The Florida Experiment Station has conducted a number of fertilizer experiments with pineapples. The result of

these experiments suggest that if the plants are set in July or August a handful of fertilizer composed of 3 parts cottonseed meal and 1 part fine ground unleached tobacco dust should be immediately dropped into the bud. This furnishes the plant food and at the same time prevents them from filling with sand.

In October or early November an application of 680 pounds blood and bone and 500 pounds of potassium-magnesium carbonate per acre should be applied. This application should be repeated the following February, or as soon thereafter as danger of frost is past. Shortly before the beginning of the rainy season a third application, consisting of 1000 to 2000 pounds blood and bone and from 750 to 1500 pounds of potassium-magnesium carbonate should be given. This should be followed by another application in October or early November.

The pineapple grown in Florida is the Red Spanish. In Hawaii Smooth Cayenne is the favorite.

Enemies: In Hawaii the pineapple does not thrive on highly manganiferous soil. Spraying with a solution of iron sulphate proved to be a complete remedy for this trouble.

BASE ROT of suckers and BLACK ROT of fruit are caused by the fungus *Thielaviopsis paradoxa*. Drying the end of suckers before planting, and treating the cut end of the fruit stem with benzoic acid help prevent the entrance of the fungus.

RED SPIDERS sometimes multiply greatly at the base of the leaves in Florida plantings. An application of tobacco dust has given satisfactory results.

PLUMS

As is the case in several lines of specialized farming, California has the lead in plums, producing 90 per cent of the commercial crop of plums, and prunes, for market, as fresh fruit, and about 96 per cent of the dried prunes, followed by Oregon, Washington, Idaho and Michigan. There are about 21½ million bearing trees in the country, of which California claims 13 million.

In the coast counties of central California the French Prune and the Imperial Epineuse are the chief varieties. The interior valleys of California give attention to many varieties for the fresh and dry trade. In Oregon, Washington and Idaho the Italian Prune is the most important variety both for canning and drying. The preferred varieties in the Central States are Stanley, Grand Duke, Pacific and Damson, but the large, blue, freestone sorts sell best locally and the Sugar Prune is gaining in popularity. Plums are a little less sensitive to cold than are peaches, and the European, American and Japanese hybrid kinds are generally most resistant to low winter temperatures. The European types are grown chiefly from Ohio eastward, while the Japanese varieties range from Vermont to California and the Southern States. The American or native plums are inferior in quality. But the Wild Goose, the most frequently planted member of this group, might be included in the home orchard. Too many growers of orchard fruits have depended upon one or two kinds, usually peaches and apples. Farm records in the Central and also the far Northwest States show that the fruit growers who raise 3 or 4 kinds of fruits, say peach, apple, pear, and plum receive much better average financial returns over a period of 10 years than the growers who stick to only one kind of orchard tree.

Soils. Most of the European or Domestica plums, including the Damsons, thrive best on a heavy clay soil. The Japanese require lighter soils, and some varieties do well on even the lighter sandy soils. The native plums grow on a vast range of soils, many thriving especially in the moister loams. In general any good apple or potato soil will be suitable for plums. Heavy or wet soils must be thoroughly underdrained.

Planting. Plum trees should be set about 15 to 25 feet apart each way. Some of the larger growing sorts like Burbank should be given 30 feet. The trees may be set either in the fall or spring, but in most cases in the North, spring planting will give the better results. Strong 1 to 2-year-old trees should be used. The 2-year-old trees are especially desirable with the Domesticas, including Damsons. In setting out the trees all broken or injured roots should be trimmed off and the top pruned to a straight whip 2 to 3 feet high, with all side branches removed. The tree should be planted to about the same depth that it stood in the nursery, or a little deeper. About 4 or 5 branches may be allowed to form the framework of the top. These should start from different places on the trunk. The head should be started as low as possible and still permit of the working of the curculio catcher below it. The first spring after planting the 4 or 5 branches should be shortened in 6 to 18 inches from the trunk, depend-

ing on the vigor of the tree. The weaker the tree the more it should be shortened in. On each of these primary branches about 2 secondary branches should be allowed to develop. Generally the plum will not require much shortening in and pruning suitable to the apple will apply to it. At about the end of the second year in the orchard the trees will come into bearing and give a moderate crop the third year.

Cultivation and Fertilizers. Plum orchards require about the same cultivation as apple orchards. They should be plowed every spring, kept cultivated every 10 days or 2 weeks up until the middle of summer, and then seeded down to some cover crop or allowed to run to weeds. In the dry, cold Northwest, however, these directions do not apply. According to Waldron of the North Dakota Station, no cover crop should be sown in the orchard, but cultivation continued until late to preserve moisture. A mulch either of straw, hay or like material should be used to cover the ground over the winter. In Wisconsin, Goff found that the mulched trees gave a superior yield and quality of fruit.

As regards fertilizers, a moderate application of barnyard manure every other year, supplemented by wood ashes, will be found to meet the demands of the plum on soils of medium fertility. On the Pacific Coast barnyard manure is preferred, but when it is not available soluble nitrogen fertilizer is broadcast about the trees 3 or 4 weeks before the blossoms appear.

Thinning and Marketing. The Japanese and the native Americana plums are very prolific, and overbearing is a frequent fault with them. Much larger fruit will be obtained, and there will be less likelihood of rot, if the fruit is thinned. For the sake of the vigor of the trees also, and the production of regular crops, thinning should be practiced. Early thinning is best, but late thinning is better than none. Thinning is seldom practiced in the production of dry prunes.

In marketing plums and for jelly making they should be picked about as soon as they are well colored. They should be gathered before they show any tendency to soften. The Japanese varieties, especially, will bear early picking and will ripen up well in the fruit packages. For home canning gather in the first stages of ripening.

In plum orchards consideration must be given to pollination. Many varieties are entirely self sterile. Several varieties should be planted in the orchard in alternating blocks of 2 to 4 rows. Both the French and Italian prunes are self-fertile, but most other varieties require proximity to good pollenizers. Even such interplanting of varieties may not give assurance of maximum crops. The presence of bees at bloom time is considered a necessity.

The prune harvest in California is less costly than picking plums for the fresh market. Prunes are allowed to ripen on the trees and fall, or are jarred or shaken off onto a canvas and transferred to lug boxes to be taken to the drying yard where they are sun dried in the open air. Recently some California growers have resorted to artificial drying as is the regular practice in Oregon, Washington and Idaho. The prunes are dipped in lye and spread on trays for drying. For French prunes the dipping solution contains 1 pound caustic soda to 20 gallons of water at a temperature of 200° F. for 10 seconds to a minute. Sun drying requires a week or longer. The large prunes such as Sugar, Burton and Imperial should be turned to secure even drying. In Idaho and elsewhere some of the surplus fresh prune crop is used in the manufacture of a prune juice.

Enemies: BLACK KNOT (*Plowrightia morbosa*) attacks plums and cherries, producing warty growths on the branches. Affected branches swell on one side until the bark bursts, exposing a brown, spongy mass. Old knots are black and dry. The young knots appear in the spring during the growing season, and later may be infested with insects. Affected branches should be cut off and burned. If the tree is badly infested it should be dug up and burned.

BROWN ROT. *See* under *Peach*.

PLUM POCKETS (*Exoascus pruni*) affect the ovary, causing an irregular, inflated bladdery growth without a stone. The interior of such diseased plums is hollow. All leaves from diseased trees and all affected fruit should be collected and burned as soon as they fall. It is also recommended that the ground under the diseased trees be sprinkled with air-slaked lime and that the trees be sprayed with Bordeaux mixture before the buds unfold.

LEAF CURL (*Exoascus mirabilis*) causes deformation of leaf buds and young twigs. Structures are thus produced which somewhat resemble plum pockets. Green tips of leaves are often seen projecting from the whitish mass. This trouble may be controlled by Bordeaux mixture.

Curculio (*Conotrachelus nenuphar*) is a snout beetle 1/5 of an inch long, of a brown or black color. It passes the winter under bark or rubbish and feeds upon the leaves, roots and buds. The female punctures the fruit to a depth of 1/16 of an inch, and deposits her eggs in this hole. A crescent shaped furrow is then cut, so as partly to surround the egg. Infested fruit exudes a gummy substance and falls about the time the grub is full grown. The curculio attacks plum, apple, peach, cherry and nectarine. Spraying with a solution of Paris green, 1 pound to 100 gallons of water, or with Bordeaux mixture, to which 2 ounces of Paris green has been added, is an effective remedy. The treatment should be given before the flowers appear, and again 10 days later. The adult beetle may be captured by jarring from the trees into a sheet stretched on a frame so as to surround the tree.

POMEGRANATE

The pomegranate is a bush or small tree cultivated throughout the tropics and subtropics including the Southern States and California. It is raised both for ornamental purposes and for its fruit. The flower is brilliant scarlet in color and the leaves are glossy. When ripe the fruit is red, orange or yellow, 2 to 4 inches in diameter, with a tough rind and crimson, acid pulp in which numerous seeds are imbedded. Pomegranate is propagated by cuttings. The fruit is eaten raw or is used in fountain drinks, or occasionally condensed into syrups.

QUINCE (*Pyrus cydonia*)

The quince is an old-time, hardy garden fruit. It is used for canning and preserves, but is never eaten raw as other orchard fruits are. On account of this the quince is but little grown commercially in this country. Nearly all old gardens, however, have 1 or 2 quince trees in them, and in some sections of the country like Western New York and California there are a few quince orchards of commercial importance.

Propagation. The quince is propagated by hardwood cuttings taken in the fall or winter and cut 10 to 16 inches long. The cuttings should be preserved for a couple of months in moist sand to facilitate callusing, and planted out in the open ground in the spring. On heavy soils propagation by stooling or grafting on small pieces of apple roots is resorted to. Budding on Angers quince is practiced where propagation by cuttings is not practicable. Quince trees usually remain 2 or 3 years in the nursery before transplanting to the orchard.

Soils and Fertilizers. Quinces do best on a rather heavy, well-drained clay loam, which is retentive of moisture. Good results are also obtained upon the lighter soils, but the trees are not likely to be so productive or long lived. The trees require about the same kinds of fertilizers as are given to the apple orchard. One of the most extensive growers in Western New York uses well-rotted barnyard manure and secures excellent results. Generally this should be supplemented by unleached wood ashes applied at the rate of 100 bushels per acre every other year, or with 200 or 300 pounds of muriate of potash applied broadcast and harrowed in. Phosphoric acid may be furnished in the form of bone compounds or South Carolina rock applied at the rate of 200 to 500 pounds per acre.

Planting and Cultivation. The trees in the orchard should stand 12 to 15 feet apart each way. As with other orchard fruits, shallow, clean cultivation should be practiced from early spring until August, when all cultivation should stop and a cover crop be sown.

In shaping the tree, the top should be started within 20 inches of the ground and given a wide spreading form. It will not be necessary to head the trees in much unless they make an excessive growth. The trees come into bearing in about 3 or 4 years after they are set in the orchard, but do not reach full bearing until 8 or 10 years old. Fair, average trees will yield 1 bushel of marketable fruit annually. Some years this amount may be doubled. The best grades should be marketed in small packages containing from a peck to a bushel of fruit, while the poorer grades may be packed in barrels.

Varieties. There are but few varieties of quince in cultivation. The Champion, a large, pear-shaped sort is one of the most productive, but it matures too late for some localities. It is an excellent keeper, and in a test at the New York Cornell Station, did not begin to get yellow or soften up until the middle of January, when other sorts had begun to show signs of decay. Orange or Apple quince yields nearly as well as Champion and is probably more generally grown. The fruit is smaller and more apple shaped. Meech, Rea and Pineapple are other varieties sometimes grown.

Enemies: Black Rot (*Sphaeropsis*

malorum) attacks apples, pears and quinces. The disease appears on the fruit when it is about half grown. A discolored patch is seen on the fruit. This area soon exhibits numerous black specks. The fruit finally cracks open and usually remains hanging on the trees over winter. Affected fruit should be gathered and destroyed. Trees should be sprayed with ammoniacal solution of copper carbonate, beginning soon after the fruit sets and repeating the application 2 or 3 times.

FIRE BLIGHT. *See* under *Pear*.

RUST (*Roestelia aurantiaca*) appears on the fruit as an orange fibrous growth. The whole fruit may become affected and fall off. The same fungus causes the development of knots on the twigs. The fungus occurs in another form as the so-called cedar apple on cedar trees. Cedar trees in the neighborhood may be destroyed. Repeated applications of Bordeaux mixture will check the diseases on quinces.

CURCULIO (*Conotrachelus crataegi*) is larger than the plum curculio, with a somewhat longer snout and without any warty elevations on the wing covers. The general color is brown mottled with white. The grub may be distinguished from the larvae of the codling moth by the absence of lines. This insect attacks the quince, pear and wild haw. The most effective remedy for combating the curculio consists in jarring and the use of a catcher especially adapted to the low-growing habit of the quince. The destruction of infested fruit is not practicable, since it is difficult to determine whether fruit is infested or not. Hogs kept in the orchard may be of some help in reducing the number of curculios.

LEAF MINER (*Aspidisca splendoriferella*) is a small moth which lays its eggs on the leaves of quince, apple, pear and other related plants. On hatching the young caterpillar mines between the 2 surfaces of the leaf. Later it cuts through the surface of the leaf and fastens the edges together to form a case, in which it migrates to a branch of the tree, where it passes the winter. When the miners occur in large numbers they may be scraped from the branches and trunk, where they attach themselves, or the trees may be sprayed with kerosene emulsion after the leaves have fallen. In some localities the cases are attached to evergreen trees in winter.

For other insect pests *see* under *Apple*, *Plum* and *Cherry*.

RASPBERRY

Of the three types of raspberry (red, black and purple) the red is the most important. The cultivated varieties of the red come from the native species (*Rubus strigosus*), or imported European sorts or hybrids of the two. The chief varieties of red raspberries are Ranere, Cuthbert, and Latham. Black-caps all come from the wild American black raspberry (*Rubus occidentalis*). The leading commercial varieties are Farmer, Cumberland and Munger. They are somewhat more sensitive to frost than the red varieties. The purple raspberries are hybrids between the red and black sorts, and the best known varieties are Columbian and Potomac. Occasionally plants of the red, black or purple kinds bear yellow fruit, but the standard yellow variety is Golden Queen, grown mostly in home gardens.

This bramble fruit is popular everywhere in home gardens, but its culture on a commercial scale is largely confined to the Northeastern States and the Pacific Coast. It is the most important of the bush fruits. The black raspberry is more easily grown, yields heavier and the fruit stands shipping better than the reds, though the reds are more relished. Black raspberries are also grown extensively for evaporating, but the acreage is far smaller than that of the red raspberry.

Soils and Manures. Deep, moist soils well underdrained are most satisfactory for raspberries. The red raspberries do better on the lighter loams, while the heavier, richer loams are better for the black-caps. The best fertilizers for raspberries are those that add humus to the soil like well-rotted barnyard manure; but on fairly rich soils the amount applied to red raspberries should be limited, as it tends to force growth too much.

Propagation and Planting. Black-caps are propagated by rooting the tips of growing canes late in the summer. When these are well rooted they are cut from the mother plant and used for setting out in the new plantation. Red raspberries are usually propagated by suckers thrown up from the roots, but root cuttings may also be used. With varieties which do not produce suckers freely the roots may be found to be of greater productiveness by cutting off all the roots. All the cut-off roots immediately throw up new stems. The plantation may be set out either in the fall or spring, but the spring is usually to be preferred.

The rows of raspberries should be 6 feet apart and the canes set 4 to 5 feet

apart in the row. This permits of horse cultivation both ways. The plantation should be kept thoroughly cultivated each season, but spring plowing, as in orchards, is unnecessary and undesirable. In most of the Eastern States the shallow cultivation practiced should cease about midsummer and some cover crop be sown, but in the drier portions of the Plains States cultivation should be kept up until the fall to preserve soil moisture.

be dried it is picked by holding an especially made tray under the bushes and knocking the berries off with a small paddle into it. By this method a picker can gather 6 or 7 bushels per day. Some leaves and trash fall into the tray with the berries, but all are dried together and then run through a fanning mill, which readily cleans the berries. Red raspberries are soft and are usually marketed in pint boxes. The Cuthbert is sometimes dried.

PICKING RASPBERRIES

Pinching and Pruning. Red raspberries require no summer pinching whatever except a little the first year or so. The black-caps, however, should be nipped off as soon as they attain a height of 18 to 24 inches. The following spring the laterals of the black-caps should be cut back to 1 or 2 feet, and the reds to a height of 2½ or 3 feet. They are cut back most on poor soils or with weak canes. The fruit of the raspberry is borne upon short fruit stalks produced from the wood of the previous season's growth. Old cane, therefore, that has fruited once should be removed after the crop is harvested.

Harvesting and Yields. Raspberries that are marketed in the fresh state are usually picked by hand. If the fruit is to

The average yield of black-caps with good culture is 60 to 80 bushels per acre, though the yield sometimes runs up to 10,000 quarts per acre. Red raspberries yield 50 to 70 bushels per acre and sometimes 6000 to 8000 quarts. It requires about 4 quarts of berries to make 1 pound of dried product. It is not generally profitable to fruit plantations more than 3 or 4 years before plowing them up. Raspberries should not be planted on the same ground again for 3 or 4 years.

Winter Protection. Raspberries are not quite so hardy as currants, and in many situations in the Northwest it is necessary to protect them in winter. This is done by removing some of the soil from one side of the roots and bending the canes over lengthwise of the row and

covering with coarse manure. The work should be done in the fall before the canes freeze or they will break in bending. In the spring the mulch should be taken off about corn-planting time and the canes righted.

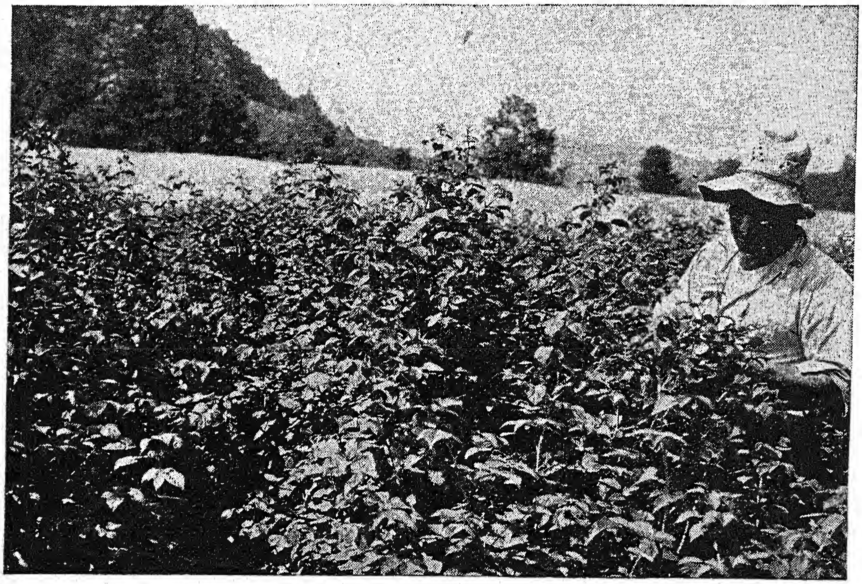
Enemies. ANTHRACNOSE (*Gloeosporium venetum*) appears on young canes as small round light spots with a purple ring. Large scabby patches develop on the old canes. The disease may be entirely controlled by cutting out and burning affected canes and by repeated applications of Bordeaux mixture.

CROWN GALL. *See* under *Apple.*

LEAF SPOT (*Septoria rubi*) attacks dewberry, blackberry and raspberry. It appears on the leaves as large spots containing minute black specks. The disease is not often of great importance. Affected canes should be destroyed.

CANE BORER (*Oberea bimaculata*) is a yellow colored grub, ¼ of an inch in length. The adult is a black beetle which lays its eggs in June near the tips of blackberry and raspberry plants. The grub burrows downward in the cane and reaches the roots in the fall, passing the winter in the ground. The female girdles the stem at 2 points about ½ an inch apart, and deposits eggs between these rings. Wilting of the tips indicates infestation by this insect. Such canes should be cut off below the lower ring and burned.

CANE MAGGOT (*Phorbia rubivora*) is a white, small, footless larva of a grayish-black fly which somewhat resembles the house fly. The insect attacks red and black raspberries, depositing its eggs in April. The maggot burrows into the pith of the canes and after making its way about half the height of the cane, girdles the stem on the inside. Girdled stems soon wilt or fall over. Infested canes should be cut off near the ground and burned.



PICKING RED RASPBERRIES

SAWFLY (*Selandria rubi*) is a black, 4-winged fly, which appears in May and June. The eggs are laid in the substance of the leaves. The larva upon hatching feeds upon the foliage. The larvae are nearly white at first, but soon become dark green in color. They may be easily destroyed by the use of arsenical poisons, hellebore or pyrethrum.

A **Trailing Raspberry** (*Rubus parvifolius*) was imported from Korea in 1929. It thrives farther south than either red or black sorts, and readily hybridizes with them but is not equal to the red in flavor.

ROSELLE (*Hibiscus sabdariffa*)

Roselle, a subtropical plant of the mallow family, resembling the ornamental hibiscus, produces a fruit composed of the

thickened calyx and bracts of the blossom from which jellies, jams and an acid fruit drink are made. Roselle has a large yellow flower, reaches a height of 4 to 7 feet and bushes out into many reddish branches. The fruit is gathered when full grown, plump and bright red, about 3 or 4 weeks after flowering. The yield runs from 3 to 15 pounds per plant. Roselle may be grown from seed or cuttings and planted in rows about 4 feet apart both ways. The first attempt to market a fruit drink made from roselle in Hawaii failed to arouse much interest. Later efforts in Florida met with more success.

SERVICEBERRY (*Amelanchier* spp.)

Serviceberry is also known as Juneberry or shad bush. Small trees or shrubs with edible fruits resembling blueberries in form. The fruit is native in nearly all parts of the United States and there are several species. Some of the dwarf forms have been introduced into cultivation but the fruit is not yet popular. The dwarf form, *A. Canadensis,* is one of the most promising forms. *A. alnifolia* produces a large amount of fruit of fair quality. The serviceberry is propagated either by seed or by sprouts which spring up around the base of the plant.

STERILITY IN PLANTS

This refers more particularly to the inability or partial inability of some plants to set fruit when fertilized with their own pollen. Waite first showed that "many of the common varieties of pears require cross pollination, being partially or wholly incapable of setting fruit when limited to their own pollen." The pollen of one variety of pears may be abundantly able to pollenize the blossoms of another variety blooming with it though it is not capable of pollenizing the blossoms on the same tree or of other trees of the same variety. Two varieties which are absolutely self-sterile to their own pollen may be abundantly able to produce fruit when the pollen of the one is used to fertilize the blossoms of the other. The self-sterility or fertility of many other fruits has been studied. Waugh and others have shown that for practical purposes all varieties of native and Japanese plums may be considered self-sterile to their own pollen. Fletcher has shown that self-sterility is not a constant character with any variety, but that the same variety may be self-sterile in one place and nearly self-fertile in another. Even when varieties are self-fertile to their own pollen, many experiments have shown that larger fruit is usually obtained when the blossoms are cross pollinated.

The practical conclusions brought out by these investigations is never to plant large blocks of one variety of fruit alone. The orchard may be barren as a result. At least every third or fourth row should be planted to another variety. Care should be taken to select varieties for pollinating each other that bloom together and are interfertile.

The most important agent in effecting the cross pollination of fruit is insects. The wind plays but a small part. A few hives of bees should always be kept where large orchards are planted, to insure cross fertilization. Honey bees are the most valuable of all the insects in securing the cross pollination of fruits.

Some varieties of strawberries produce only pistillate blossoms. Such varieties, of course, produce no fruit whatever unless planted with other varieties that produce an abundance of pollen. Where the male and female flowers are borne on separate plants, or on separate parts of the same plants, insects to carry the pollen to the pistillate flowers are practically essential to the successful setting of fruit.

SPRAYING AND OTHER MEANS OF COMBATING FUNGOUS DISEASES AND INSECT PESTS

In the older, more thickly settled portions of the country where fungous diseases and injurious insects have become established, there is no longer any question as to whether it pays to spray. In many localities it is impossible to secure a good crop without spraying. Moreover, careful extensive experiments have demonstrated that the expense of spraying is always justified by the increased returns.

Fungicides are substances which are used for the prevention or eradication of fungous diseases. In the following paragraphs the more important fungicides are considered.

BORDEAUX MIXTURE is made of copper sulphate, quicklime, and water.
The so-called "standard" formula is:

Copper sulphate	6 lbs.
Quicklime	4 lbs.
Water	22 gals.

While the "normal" formula is as follows:

Copper sulphate	6 lbs.
Quicklime	4 lbs.
Water	45 gals.

Recently formulas requiring 50 gallons of water have been extensively used, and equal amounts of copper sulphate and lime are recommended. The strong solution, now most generally in use, contains 4 pounds of lime, 4 pounds copper sulphate and 50 gallons of water, while the dilute solution contains ½ the quantity of lime and copper sulphate, or 2 pounds each. For making Bordeaux mixture the proper amount of copper sulphate may be dissolved by suspending it in a cheese cloth bag in a bucket of water. After being completely dissolved it may be poured into the tank or barrel used for holding the solution. The barrel should be partly filled with water. Thoroughly slake the lime, strain the milk of lime thus obtained into the barrel and add water to make 50 gallons.

Bordeaux mixture is almost a universal fungicide. The 4-4-50 formula may be used on nearly all plants, except cherry, peach and watermelon, on which the 2-2-50 formula should be used.

SIMPLE SOLUTION OF COPPER SULPHATE is made by dissolving from 2 to 4 pounds (according to desired strength) of copper sulphate in 50 gallons of water, as recommended for making Bordeaux mixture. It may be combined with the arsenites but is apt to injure the foliage and should be used before the buds unfold.

Two dust treatments for garden seeds are much in use. Copper sulphate dust is applied to seed at the rate of 1 tablespoonful to ½ pound of seed and shaken together till the seed are thoroughly coated. Red oxide of copper dust is employed in the same way, 1 tablespoonful to 3½ ounces of tomato seed or 1 teaspoonful to a pound of small seeds.

POTASSIUM SULPHID is a very effective fungicide but it rather too expensive for use in extensive spraying. For such purpose it is used at the rate of ¼ to 1 ounce in 1 gallon of water. In treating seed grain for smut, potassium sulphid is used at the rate of 1½ pounds to 25 gallons of water.

CORROSIVE SUBLIMATE, or bichlorid of mercury, is chiefly used as an antiseptic or disinfectant, or in the treatment of seed potatoes for scab. For that purpose it may be used in a solution containing 1 ounce to every 7 gallons of water. It is very poisonous and corrosive to metals.

FORMALIN, also called formol or formaldehyde, is probably the best fungicide for use in the prevention of grain smut and potato scab. The commercial formalin contains a 40 per cent solution of the gas in water. It is nonpoisonous and noncorrosive. The fumes are somewhat irritating to the eyes and nose. Seed potatoes may be soaked for 2 hours in a solution containing ½ pint formalin in 15 gallons of water. Seed wheat or oats may be soaked for the same length of time in a solution containing 1 pound (1 pint) fomralin in 50 gallons of water.

SULPHUR has long been used quite extensively in the treatment of surface mildews of plants. Outdoors it is applied in a dry condition, while in greenhouses it is frequently used as a spray at the rate of 1 pound to 5 gallons of water. The fumes of sulphur have considerable fungicide and insecticide value. They may be most successfully produced by evaporating the sulphur over a sand bath or water bath. The sulphur should not be allowed to take fire, for all plants are destroyed by its action when burned.

HOT WATER as a fungicide is chiefly used in the treatment of seed grain for smut.

Many other fungicides have been proposed and used to some extent, but the list given above includes all the important ones which the practical man will find useful in combating the fungous diseases of his crops.

Insecticides. The substances which are used as chemical insecticides may be conveniently divided into 2 classes, those which are eaten and kill by poisoning and those which destroy by contact of the fluid, gas or dust. Of the first class of insecticides the most important group depend for their poisonous property on the presence of arsenic in some form or other, and they are usually known as arsenicals. A large number of arsenicals have been used, but brief notes are here given only on the most important ones.

DERRIS DUST. Among the newer developments in the use of insecticides the results obtained in applying derris dust and other plant dusts containing rotenone are the most interesting. Already the literature bearing on these dusts runs into thousands of scientific and popular reports on the results shown by their use. Derris root had long been known as a fish poison used by the natives of Malaya. Recently it has come into wide insecticide importance. It kills all kinds of insects as a quick poison if eaten or by mere contact, and it is not poisonous to man. During the past decade it has been found that the active principle in derris is rotenone, and that rotenone is also found in various other plants, notably cubé, timbo, bar-

basco, haiari and Tephrosia virginiana, a rather common U.S. weed known by the sinister name of devil's shoestring. Dusts made by grinding the roots of these plants have been proved to be phenomenally effective against such a wide variety of insect pests as cabbage caterpillar, pea louse, Mexican bean beetle, pea weevil, turnip louse, cattle grubs, fleas, bird lice, grasshoppers, thrips, European corn borer, melon worm, flea beetles, carpenter ants, etc. So far all the plants which have been found to contain rotenone are legumes.

Paris Green is perhaps the best known and the most extensively used arsenical on the market. Since the Colorado potato beetle has become an important insect pest until the present time, Paris green has been almost the only remedy used for this insect. Paris green should be of a uniform bright green color and should contain not less than 50 per cent of arsenic, nearly all of which should be in an insoluble form. It may be used for dusting foliage in a dry condition, and when so used should be mixed at the rate of 1 part to 10 to 20 parts of flour, ashes or dust. When used in solution with water it should be applied at the rate of 1 pound to 100 gallons of water. For tender foliage, such as that of peaches, it should be used in a more dilute solution, as for instance 1 pound to 200 gallons of water.

Arsenate of Lead was first brought into prominence as an insecticide by the Gypsy Moth Commission of Massachusetts, and later was used almost exclusively by this commission in its spraying operations. The action of arsenate of lead is slower than that of Paris green, but it can be used in greater strength without danger of injuring the foliage, and remains as a whitish coating on the leaves so that it is easily determined whether or not it has been washed off by rain. Its adhesive qualities are considerably greater than those of Paris green, and it remains on the leaves for a much longer period. Arsenate of lead may be made at home by combining 30 parts of arsenate of soda and 70 parts of acetate of lead. In practice, however, it has been found more satisfactory to buy the arsenate of lead from reliable firms. Calcium arsenate may be used instead of lead arsenate for practically all purposes.

In the use of arsenicals the objects aimed at are an effective destruction of injurious insects with a minimum amount of danger to foliage. Paris green, arsenate of lead, London purple and arsenite of lime answer these conditions very well when used in an intelligent manner, and there is no necessity for resorting to patented or doubtful arsenical insecticides until experience has shown that they are equally as effective and not injurious to the foliage.

Hellebore is a yellowish powder made from the roots of European or American hellebore. It is much less poisonous than the arsenicals and loses its strength when exposed to the air for any great period. It may be applied dry or mixed with water. In the form of a powder it may be dusted upon plants in the pure form or mixed with flour, plaster or lime. When used in water it may be applied at the rate of 1 ounce to 3 gallons of water. It is especially recommended for use in the destruction of turnip and gooseberry worms and the larvae of sawflies. For such purposes it may often be used when the application of arsenicals would perhaps be objectionable.

Hydrocyanic-acid Gas was first used extensively in the destruction of scale insects in California and has since become a well-known and effective remedy for this purpose in all parts of the country. The fumes are exceedingly poisonous and strict precautions should be taken against the possibility of breathing them. The gas is generated by combining cyanid of potash, sulphuric acid and water. For fumigating nursery stock in a tight building or a room 1 ounce of potassium cyanid 98 per cent, 1 ounce of commercial sulphuric acid and 3 ounces of water should be used for every 100 cubic feet of space. For green plants or foliage of tender varieties the same amount of chemicals may be used for every 150 cubic feet. For mixing the chemicals an earthenware vessel of 1 or 2 gallons capacity is most suitable. It should be placed on the floor of the room and the necessary amount of water should first be added, then the sulphuric acid is to be poured into the vessel, and the cyanid of potash should be added last. As soon as the cyanid is placed in the vessel the room must be tightly closed immediately, and the treatment should continue for 40 minutes.

In the fumigation of growing trees, several styles of tents have been used, as well as portable boxes or houses which can be readily placed over each individual tree. The general procedure is the same, but the cubic contents of the tents have to be estimated since their form is usually quite irregular. For fumigating small orchard trees a convenient portable box was

devised at the New York State Station which possesses the advantage of being readily managed by 2 men and not breaking or otherwise injuring the small branches of the tree. This method of treatment is the most effective which has yet been devised for destroying scale insects upon citrus and other fruit trees, as well as in greenhouses. It is equally effective against all other insects which may happen to be upon the trees at the time of fumigation, and in fact about the only pests which resist its action are red spiders. If only a few trees require treatment, the method of fumigation may perhaps be considered too expensive, but where treatment must be applied on a large scale it is the best method to recommend.

FLUORINE INSECTICIDES. "There are on the market a number of insecticides such as sodium fluosilicate and cryolite, in which the poisonous principle is some compound of fluorine. These insecticides are especially useful in the control of the Mexican bean beetle, cabbage worms and the flea beetle. These preparations should not be applied to the crop when the foliage or fruits that will be marketed or eaten are on the plant, unless the residue can be removed by washing or stripping."

CARBON BISULPHID, as sold on the market, is a colorless inflammable liquid. It is very volatile and as soon as exposed to the air gives off the heavy gas which penetrates all parts of the enclosed space. This substance is especially recommended for the destruction of gophers, ground squirrels and woodchucks, as well as various underground insects, such as the woolly aphis and phylloxera. It has also been used against cabbage root maggot and ants. Carbon bisulphid is almost the only remedy which is generally used in the destruction of grain insects. For the destruction of underground insects it may be poured into the holes, and the holes immediately closed, or may be injected into the soil by means of a syringe for the purpose.

CRUDE PETROLEUM has been used either undiluted or in a mechanical mixture of water, in all cases where kerosene has previously been recommended. In some respects it has proved more effective and more satisfactory than kerosene. A coating of crude petroleum remains longer on the trees and it is more readily determined whether the tree has been thoroughly sprayed. The same precautions are to be observed in spraying with crude petroleum as with kerosene, and it appears from some experiments that all insects are destroyed by spraying with a 25 per cent mechanical mixture of crude petroleum and water.

The California State Board of Horticulture recommends a distillate emulsion which is essentially an emulsion of crude petroleum and soap. As generally used it contains 1½ pounds of whale-oil soap to 5 gallons of the distillate oil. This insecticide is similiar to kerosene emulsion, and before using is diluted with from 12 to 15 parts of water. It is used as a wash for the destruction of scale insects and the eggs of plant lice.

KEROSENE EMULSION is made with soap or with milk. The soap formula contains 2 gallons of kerosene, ½ pound whale-oil soap, or the same amount of hard soap, and 1 gallon of water. The soap should be dissolved in boiling water and the solution mixed with the kerosene by violent agitation. Before using it may be diluted with from 15 to 20 parts of water, according to the plants which are to be sprayed. Kerosene emulsion is especially recommended for the destruction of plant lice, leaf-hoppers and thrips. The milk formula contains 2 gallons of kerosene and 1 gallon of sour milk, which are made into an emulsion by from 3 to 5 minutes' agitation. The mixture should be diluted the same as in the soap formula.

Kerosene, when applied to the surface of pools and stagnant water, at the rate of 1 ounce to 15 square feet of surface, is a very effective remedy for the destruction of mosquito larvae. Kerosene and petroleum, whether undiluted, mixed with water, or in the form of emulsions, should be used in an economical manner, partly because insecticides with these substances are rather expensive, and partly because injury may result to the bark or leaves from an excess of kerosene upon the foliage.

TOBACCO is employed as an insecticide in several ways. It is chiefly effective against plant lice and other sucking insects. Greenhouses may be effectively fumigated by burning tobacco stems. Tobacco dust and stems are often buried in the soil around apple trees infested with woolly aphis. The water soaking through the soil carries with it a solution of the tobacco which destroys the woolly aphis. A decoction of tobacco is made by steeping the stems in water until the strength of the tobacco is thoroughly extracted and then diluting the solution until it has the color of ordinary tea.

SOAPS are frequently used for the de-

struction of plant lice and soft-bodied larvae. Any good soap is fairly effective for this purpose, but whale-oil soaps are especially valuable. Potash soaps are considered more effective than those made from soda. Soft soaps may be used as well as hard, but should be taken in larger quantities. Whale-oil soap may be dissolved in water by boiling 2 pounds in a gallon of water. This insecticide is not only useful against plant lice, but is also recommended as an effective winter application against San Jose scale and other scale insects.

PYRETHRUM, also known as buhach and Persian insect powder, is made of the pulverized flowers of Pyrethrum plants. It is chiefly used in greenhouses and in the destruction of household insects, where arsenical poisons might be dangerous or otherwise undesirable. It is used in the form of a dry powder or as a spray at the rate of 1 ounce to 2 gallons of water. For the destruction of mosquitoes in houses, pyrethrum produces effective fumes when burned.

SULPHUR is perhaps the best remedy for plant mites, such as the common red spider, the rust mite of citrus trees, and the 6-spotted orange mite. For this purpose it may be best applied as a dry powder and dusted over the trees with powder bellows. Sulphur may also be added to other insecticides, such as resin wash, soap mixtures or kerosene emulsion, at the rate of from 1 to 2 pounds to 50 gallons of the insecticide. A lye-sulphur wash may be mixed by making a paste of 20 pounds of sulphur, to which 10 pounds of pulverized caustic soda is added. Water is to be poured upon the mixture from time to time until a solution of 20 gallons is obtained. This may be used as a stock solution, and for spraying purposes 2 gallons of the stock solution may be diluted to 50 gallons.

HOT WATER furnishes means for destroying root lice, especially the woolly aphis. Water at nearly a boiling temperature may be poured about the base of young trees without danger of injuring the trees. Before applying the hot water a few inches of the soil should be removed from around the tree. Infested nursery stock may be treated by immersion for a few seconds in water maintained at a temperature of from 130 to 150 degrees F. For the destruction of pea weevils it has been found sufficient to expose seed peas for a short time to a temperature of 145 degrees F. The same result may be obtained by soaking infested seed for 1 minute in boiling water.

Mechanical and Other Methods of Fighting Insects

BANDING of trees has been quite generally employed as a means for preventing insects from climbing up into the trees from the ground. It is especially effective in cases where the female insect is wingless, and for preventing the ascent of caterpillars. The female canker worms are thus captured, as well as the caterpillars of various other species. For such cases tarred paper or tarred bands made in other ways are easily adapted. Bands of burlap, other kinds of cloth and straw are used for the purpose of entrapping caterpillars. Such bands are inspected at regular intervals, and any caterpillars which have collected under them are destroyed. Experiments have shown that this method is quite effective in some localities against the codling moth. Banding trees with burlap has been most extensively adopted by the Gypsy Moth Commission in combating the caterpillars of the gypsy moth.

JARRING is a method especially suited to catching insects which readily drop to the ground when disturbed. The insects against which the method has been most used are the plum curculio, rose beetles, tarnished plant bugs, and caterpillars which drop from the trees and hang by a thread. For catching such insects when jarred from infested plants it is necessary to have some form of a sheet or canvas stretched on a frame under the tree at the time of jarring. The insects are then to be immediately destroyed. In the case of the tarnished plant bugs and rose beetles the jarring method can only be successfully operated during the cool part of the day when the insects are not especially active.

DEEP PLOWING. In the case of certain insects which pass the immature stages in the ground, the larvae may be so deeply buried by plowing that they are unable to reach the surface. This method has been successfully used in combating the Rocky Mountain locust. In this case the eggs are laid at the depth of about an inch or two, and when deep plowing is resorted to the young locusts are unable to escape after hatching.

BURNING is a remedy which may be applied in a great variety of cases. Badly infested strawberry beds should be mowed immediately after harvest and burned over. Where wheat is infested with the Hessian fly, the stubble should be burned

as soon as possible after harvesting. In general, where cultivated crops are infested with insects which pass any of their stages under leaves or other rubbish on the ground, it is advisable to burn such material at a time when the insects will be destroyed. The Rocky Mountain locust in its younger stages may be enticed under straw and then destroyed by burning the straw in the evening after the locusts have collected together.

TRAP CROPS. The intelligent use of trap crops sometimes furnishes an effective means for getting rid of certain injurious insects. It often happens that insects prefer certain other plants to the one which is being cultivated on a given area. By cultivating a few of these preferred food plants around the field of the cultivated crop, and then spraying such trap crops heavily with Paris green or other arsenical poison, the insects may be readily destroyed. In such cases the arsenicals may be used in stronger solution than would be advisable upon the plants which are desired for food or other economic purposes.

HOPPER-DOZERS were first devised for the destruction of Rocky Mountain locusts and other locusts. A form of hopper-dozer has also been found effective in combating leaf-hoppers on grasses. The most common form of hopper-dozer consists of a pan of galvanized iron or similar material, about 4 inches deep in front and 8 inches deep at the back. The pan is usually about 2 feet wide and may be of any convenient length. For use on a large scale a long pan is desirable. The pan is divided at intervals of 12 inches by partitions of galvanized iron, and is mounted on a platform, which in turn is carried upon wheels or runners. The whole apparatus is propelled by horses, and as it is drawn across the field the grasshoppers spring into the air and fall back into the pan. The pan should be nearly filled with water, upon which a film of kerosene oil is maintained. This apparatus is especially useful after the insects are able to fly vigorously.

DITCHES AND IRRIGATION. Insects which travel in armies, such as the army worm, chinch bug and certain species of cutworms, may sometimes be prevented from entering fields that contain cultivated crops by erecting barriers of boards smeared with tar or crude petroleum, or by digging ditches with a perpendicular wall toward the cultivated crop. The ditches may be supplemented with holes dug at intervals, into which the insects fall and in which they may be destroyed. Where water is to be had for irrigation purposes an effective method of stopping an army of cutworms or other insects consists in running an irrigation ditch between the army of insects and the cultivated crop and keeping a regular and constant stream of water flowing in the ditch.

Where irrigation is practiced it is easily possible to destroy certain insects by irrigating the fields or submerging them for a certain length of time under water. The latter method is frequently adopted in combating injurious insects in cranberry bogs. In case of the ordinary cultivated crops irrigation is not especially effective in destroying insects, since the crops are liable to injury from overirrigation and insects are not destroyed by short immersion in water.

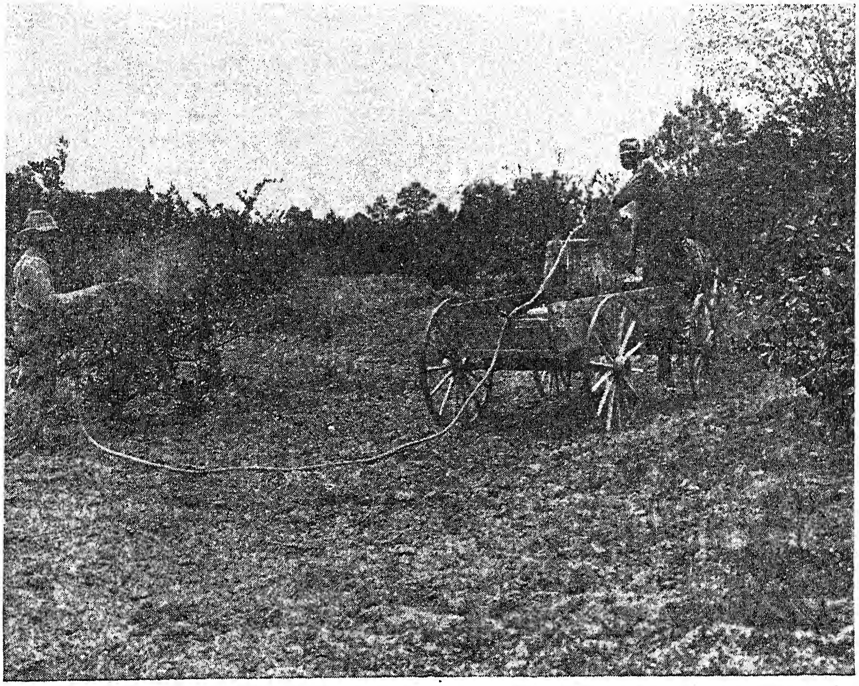
ROLLING. Cutworms and Army worms may, under certain conditions, be destroyed in large numbers by rolling with a heavy roller. This method is not effective when the insects are hidden in the soil, but it is only to be adopted when they are crawling upon the surface. When fields of grain 3 or 4 inches in height are attacked by cutworms or army worms the method of rolling may often prove of great service.

POISONED BAIT is the best remedy for cutworms, army worms and grasshoppers. It is easily made by mixing 2 tablespoonfuls white arsenic with 5 pounds of bran to which are added ½ pint molasses and 5 quarts of water.

EGGS AND COCOONS. The egg masses and cocoons of certain insects are very conspicuous and may be readily detected, collected and destroyed. This method should be adopted to some extent in all cases where it is readily practicable. The collection or destruction of egg masses is possible in the case of the gypsy moth, apple-tree tent caterpillar, white marked tussock moth and various other insects. The cocoons of some insects are attached to twigs or other objects, where they can be readily seen and may be collected and placed in cages made of fine meshed wire so as to prevent the escape of the insects and to allow any parasites which they may contain to make their escape.

FIGHTING INSECTS WITH FUNGOUS DISEASES. Various species of insects are often attacked and destroyed by parasitic fungi and bacteria. Considerable work has been done in this and other countries in making artificial cultures of parasitic fungi for the purpose of distributing such

fungi or diseased insects among farmers and fruit raisers. In fighting the chinch bug considerable success has been had by the use of a fungus known as *Sporotrichum globuliferum,* which causes a so-called white muscardine disease of chinch bugs. This has been cultivated at several experiment stations and at the State University of Kansas for distribution among farmers who are suffering from attacks of chinch bugs. A fungous disease of San



HOME MADE SPRAYER

Jose scale has been discovered which seems to be of considerable importance in checking this insect, as well as the fluted scale and other scale insects. The disease has been experimentally disseminated by means of twigs infested with diseased scale insects.

Beneficial Insects. In the work of destroying injurious insects it should be remembered that considerable help is received from predaceous and parasitic insects which feed upon or destroy the injurious species. Some of the more common groups of these beneficial insects may be briefly described in this place.

Syrphus Flies are bright colored flies some of which closely resemble bees or wasps in their general appearance. The adult flies are most frequently seen around various flowers especially goldenrod. The larvae of certain species are small greenish slug-like insects, which feed almost exclusively on plant lice, and are frequently to be seen among the colonies of plant lice on fruit trees, cereals and other cultivated crops.

Lady Beetles are easily recognized by their hemispherical shape, red or yellow color and black spots. The larvae are active grubs of bright color and covered with warts or spines. Both the adults and larvae feed upon plant lice and are considered of great value for this purpose. Considerable effort has been spent in introducing species of ladybirds from other countries to the United States to help in the destruction of scale insects. The fluted scale of California was almost exterminated by a lady beetle which was imported from Australia.

Lace-Wing Flies are delicate insects with relatively large, thin pale green wings. The larvae resemble those of ladybirds, but are somewhat more slender and less spiny. They feed upon plant lice and other soft-bodied insects.

Nearly all species of insects are known

to be attacked by one or more insect parasites. The more common parasites belong to the 2-winged or 4-winged flies. These parasites may develop in the egg, larvae or pupal stage of the host insect, and usually cause the death of the latter only after a considerable period. Some stages of parasitic insects are frequently observed. The small white cocoons on the backs of tomato worms have been observed by nearly all careful gardeners, and are one stage of the parasite which destroys this enemy of the tomato. Plant lice which are attacked by parasites are distinguished by their swollen appearance and brown color, and may often be seen in large numbers among colonies of plant lice which are feeding on cultivated plants. Many experiments have been made in shipping parsites of injurious insects from one country to another to assist in the destruction of insect pests, and some success has attended these efforts. The practical farmer or gardener should be able to recognize the many forms of predaceous and parasitic insects in order to avoid destroying them along with the injurious species during his insecticide operations.

The most striking success in the use of parasites has been had by the Hawaiian Sugar Planters' Experiment Station where the cane leaf-hopper was practically exterminated by imported parasites and the cane borer and other pests brought under control.

Spraying Apparatus. The choice of machinery for spraying will depend largely on the kind of plants to be sprayed and the extent of the spraying operations. The apparatus will range in size and complexity from the simple hand atomizer for use in spraying greenhouse plants, through the various forms of bucket pumps, knapsack sprayers and barrel pumps, to the large tanks with pump attachments, operated by horse power or by gasoline or steam power. For spraying an orchard or potato field of moderate size a 50-gallon barrel or a tank holding 100 gallons is suitable. Either receptacle may be mounted on wheels or placed in a wagon. A strong force pump is to be attached and may be operated by hand or by horse, gasoline or steam power. For special purposes special devices are required. For instance, in spraying potatoes or cotton, a long horizontal extension rod may be connected with the tank and may be fitted with attachments so as to spray several rows at the same time.

All apparatus used in spraying should be strong, durable and not likely to corrode. Hose should be strong enough to endure considerable pressure. The nozzle should throw an even and finely divided spray. Much of the success of spraying depends on all the foliage being well covered without too great an excess of material in any place.

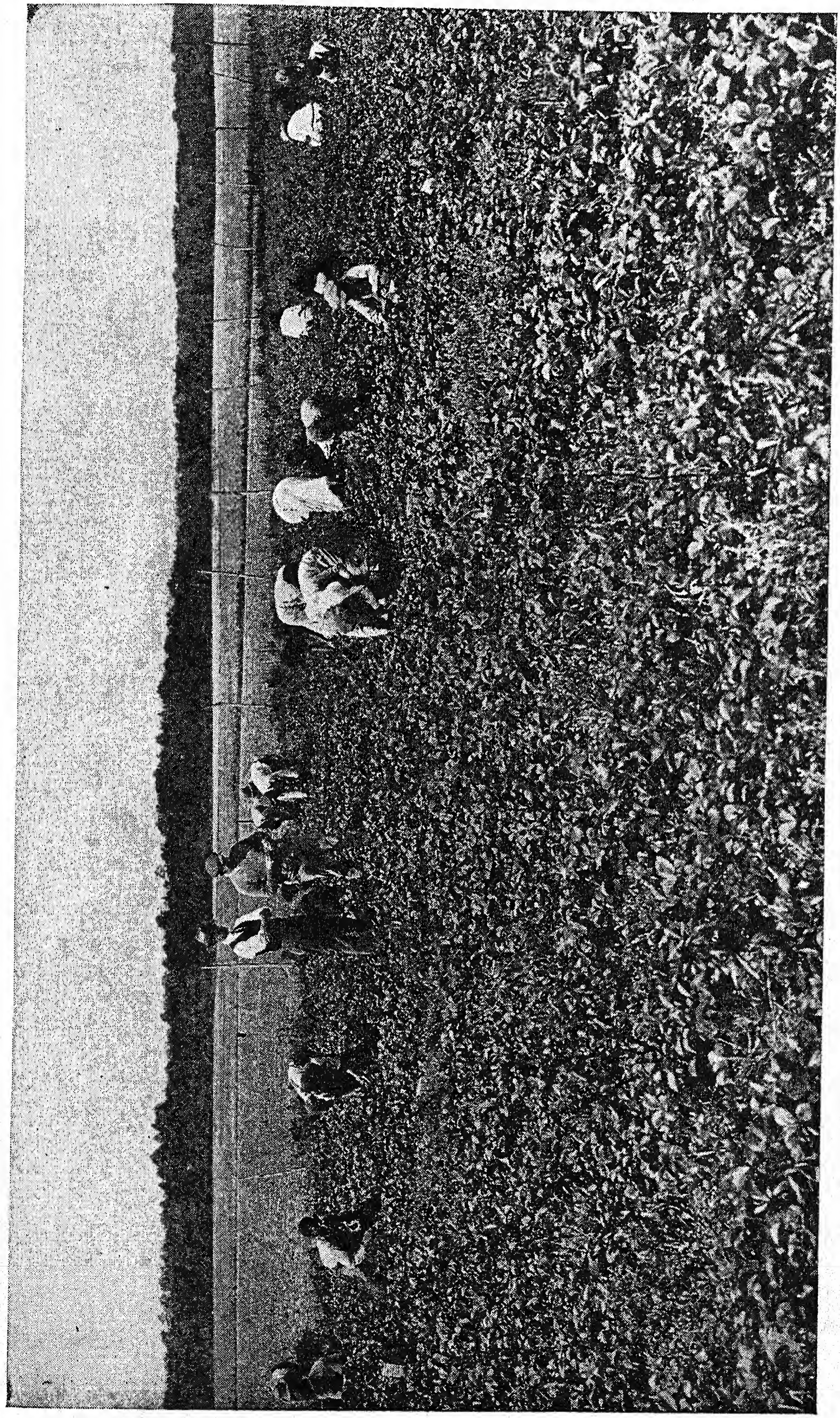
Where possible it is generally recommended that fungicides and insecticides should be combined in one spraying. The most common combination of this sort is Paris green and Bordeaux mixture. Apple trees should be sprayed 3 or 4 times each season with this combined fungicide and insecticide before the blossoms and buds open, immediately after the blossoms fall, and a third and fourth time at intervals of about 2 weeks. In this combined mixture Paris green may be used at the rate of ¼ pound to 50 gallons of the mixture.

Many other combinations of fungicides and insecticides have been tried with varying results. Attempts to combine contact insecticides, arsenicals and fungicides have been mostly unsuccessful. Recent developments, however, in the manufacture of machines for making mixtures of kerosene and water have made the preparation of combined mixtures a much simpler matter.

Finally. Success in spraying is obtained by doing the work thoroughly and in an intelligent manner. Do not spray except for a specific purpose. Do not spray fruit trees when in bloom. The bees might be poisoned and the trees fail to be fertilized. It is not always wise to wait until some fungous disease or insect pest has appeared before spraying. Where experience has taught that certain fungous diseases are to be expected, preventive treatment with Bordeaux mixture should be given before their appearance. It is always necessary to spray more frequently in rainy weather since the rain washes off the spraying materials.

STRAWBERRY

As wild plants strawberries grow in every State. Several wild species are native to the United States, but most of our cultivated forms are derived from *Fragaria virginiana.* The strawberry is by all odds the most important of the small fruit crops. Up to the time of the Civil War this berry was raised only in home gardens, or by small truckers with a very small area of distribution, so that the season was rarely more than 3 weeks. Today a continuous year-round supply is



PICKING STRAWBERRIES

available in large cities. California can supply strawberries from July to December, after which Florida and Louisiana start shipping. Strawberries on the northern market in midsummer come mostly from nearby plantations. The commercial crop now occupies 210,000 acres with a production of over 14 million crates, in which Arkansas, Louisiana, Oregon, Tennessee and Michigan figure as leaders.

The steady and increasing demand for strawberries has led to a vast amount of research by commercial growers and by Experiment Stations and federal and State Departments of Agriculture. Bulletins on strawberries published by these institutions run into the hundreds and deal with every phase of the culture and marketing of the crop.

Newly plowed sod land is not suitable for strawberries on account of the danger of root injury by white grubs. Badly weed-infested land is also to be shunned. Rotation of crops is desirable with strawberries, not so much because of exhaustion of fertility, but the special diseases and insect enemies of the crop may accumulate in the beds to a destructive degree. Tobacco, potatoes, sweet potatoes or other hoed crops may well precede strawberries.

In soils deficient in humus barnyard manure, or turned under green legumes may prepare the ground for strawberries. Unless strawberries are to be grown more than one year on the same land, it may not be necessary to apply fertilizer. Strawberries do well on almost any type of soil, sandy, loam, muck, heavy gumbo or silty. Whatever soil for each locality is most easily worked and best supplied with humus, seems to be chosen. On the coastal plains along the Atlantic fertilizers are required. A 3-6-2 formula has given good results in North Carolina. In southern Texas little or no fertilizer is used.

In western irrigated regions the strawberry is commonly grown as an intercrop between the rows of orchard trees or grapes. They may continue to occupy the ground until the apple or pear trees or grape vines come into full mature bearing. Under irrigation the second year crop is usually heaviest, but paying yields may be obtained for 3 or 4 years.

For home gardens in New Jersey strawberries are especially well adapted since the plants thrive on a wide range of soils and ordinarily do not require dusting or spraying. The plants should be set out as early as the soil can be worked in rows 3 or 4 feet apart, and the runners permitted to form a matted row 18 to 24 inches wide. If the home gardener will make an extra effort to secure larger berries he may set the plants by the hill system 15 inches apart in rows 2 feet distant. Mulching with straw or similar material is important to give winter protection, conserve moisture, keep down the weeds and prevent soil erosion.

In Ohio experiments little benefit was observed from the application of nitrogen to strawberries. Even the use of phosphorus and potash was ordinarily not profitable. Stable manure was the only fertilizer that increased yields in Iowa, where it was found that success with strawberries involved drainage, cultivation, rotation with legumes, liming and the use of phosphatic fertilizers. Weeds make strawberry plantation short lived and unproductive. Experience in Nebraska is very similar. Mulching proved necessary to reduce the damage from alternate freezing and thawing and for protection against dry winter winds.

Transplanting. Strawberries are propagated chiefly from plants which are offsets from the mother plant. They should be chosen, when possible, from parents that have not been weakened by disease, or by having borne a crop of fruit. North of Virginia early spring is the most satisfactory time for setting out the strawberry bed. In some portions of the South late summer and fall settings produce satisfactory results. With spring planting in the North the plants become well established during the summer and produce a profitable crop of fruit the following spring. Fall planting in August will give a small crop of berries the following spring. By layering the first runners in small pots much better results may be obtained.

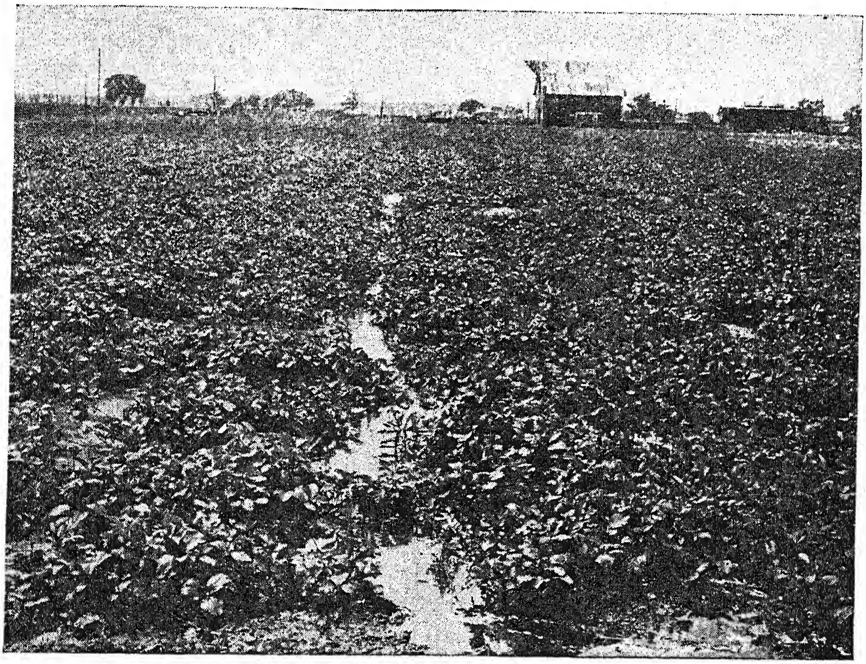
Sets used for planting out should have the roots cut back ⅓. They must be kept moist and away from drying winds. A hole is made with a dibble or trowel deep enough to put in the plants without doubling up the roots. The roots should be spread out fan-shape and the soil compacted firmly about them. The crown of the plant should set just level with the surface of the ground. If set too deep it will rot.

Strawberries are set either in hills or rows. On a small scale the hill method is satisfactory, but commercial growers generally plant in matted rows. If hills are used they may be about 3 feet apart one way and 12 to 15 inches apart the other. By the matted row system the rows are generally 4 feet apart and the

plants set 18 to 24 distant in the row. The runners from these plants are then allowed to set plants freely at a distance of 6 inches to a foot either side the row, thus making a mat of plants from 1 foot to 2 feet wide. Matted rows about 18 inches wide are most popular. Heavier yields are secured with matted rows than with hills. Spring-set plants should not be allowed to bear fruit, but should be kept well cultivated throughout the season.

the spring the mulch should be removed from over the plants to the middle of the rows. If the mulch is of pine needles or some fine material the plants will push up through it, leaving it in place to protect the fruit from the soil. If frost threatens at a critical period after the mulch is removed the crop can often be saved by putting it back over the plants.

Treatment of Beds After Harvesting. Commercial strawberry plantations should seldom be fruited more than 2 seasons.



IRRIGATING STRAWBERRIES

Mulching. In the South the principal use of the mulch is to keep the fruit clean. Straw, stable manure, marsh hay, pine needles and such material are used. Marsh hay is perhaps the best material since it is free from weed seed. The mulch should be placed 3 or 4 inches deep between the rows, but only lightly cover the plants. If the plants are covered too deep or the mulch is allowed to stay on too long in the spring the plants will bleach and weaken and suffer when uncovered and exposed to either sun or frost. On poor lands a mulch of well-rotted barnyard manure is most desirable. Mulching is especially desirable on clay soils.

As strawberry plants start to grow in

Insects, weeds and diseases usually come in by this time and make it more profitable to start new beds than to clean out the old. In the home garden the same bed is generally fruited a number of seasons. The experiments at the stations show that in general, with spring set plants, the largest berries and berries of most uniform grade and quality are obtained the first season after planting; while the earliest fruit and heaviest yield of fruit are obtained the second season. Where the strawberry bed is fruited for 2 or more seasons it is advisable to mow it after the berries have been picked, and burn it over. This practice is one of the most effective means of destroying insects and fungous diseases.

After the bed has been burned over there are several methods of putting it in shape for the following season. At the Minnesota Station a furrow is plowed on each side of the matted row and filled with well-rotted barnyard manure. The cultivator is then set going and all the weeds and old plants in the row cut out with a hoe and the other plants thinned where needed. This general plan is observed at a number of stations with variations of details. Sometimes in the case of a wide matted row all the plants are plowed up except a strip 8 to 10 inches wide on one side of the row. This leaves practically only one-year old plants in the row, thus renewing the bed each year.

Irrigation. Strawberry plants, especially at the time of fruiting, require an abundance of water. In Colorado the station advises that newly set beds be irrigated about once every 2 weeks and cultivation continued up till frost comes. Just before freezing weather sets in the plants should be well irrigated. Fruiting beds on sandy soil require irrigation twice a week, while on clay soils once a week is believed to be sufficient. The Kansas Station found that a given quantity of water was much more effective when the plants were fruiting if it was showered directly on the plants instead of letting it run down between the rows in the usual way.

Varieties. Some of the best varieties of strawberries have "imperfect" blossoms, that is blossoms which do not bear pollen. If these strawberries are set out alone they will bear no fruit whatever. If a few plants flowering at the same time and producing an abundance of pollen are mixed with them then they bear heavy crops of berries. Other varieties have "perfect" flowers and are capable of fertilizing themselves and of producing fruit when planted alone. It is a matter, therefore, of the utmost importance that the planter know beforehand whether the varieties he is to grow are "perfect" or "imperfect." The station experiments show that on the whole, these two classes of berries are equally productive, and that the frost resistance of the imperfect varieties is a little greater than that of the perfect ones. In the strawberry plantation at least every third row should be set with a perfect variety.

For specific recommendations as to varieties best suited to different localities consult your County Agent.

Enemies: POWDERY MILDEW (*Sphaerotheca castagnei*) is recognized by a curling of the leaves into a cup form. The under side of the leaves is covered with a frost-like growth. It occasionally attacks the fruit, rendering them insipid. The disease may be controlled by spraying with Bordeaux mixture or dusting the plants with sulphur.

LEAF SPOT or RUST (*Sphaerella fragariae*) produces red black-bordered spots on the leaves soon after the berries are gathered. The spots may, however, appear much earlier. The edges are often purple. After harvest the leaves should be mowed off and burned. Repeated applications of Bordeaux mixture, except during the berry season, will hold the disease in check. When strawberry patches become badly infested with fungous diseases or insect pests much good is done by mowing off the plants and burning the ground over after harvest.

CROWN GIRDLER (*Otiorrhynchus ovatus*) is a small pink or white footless grub which girdles the crown of strawberry plants in May or June. The adult is a small brownish-black snout beetle which appears in April or May and is probably single brooded. The beetle feeds on a considerable variety of cultivated plants. It is wingless and its distribution is therefore slow. Infested fields should be plowed when the larvae are only partly developed, and plants from such fields should not be used for a new plantation.

LEAF ROLLER (*Phoxopteris comptana*) is a brown moth ½ inch across the wings. It appears in early spring and deposits eggs on the leaves of strawberry, raspberry and blackberry. The larvae are greenish-brown and become full grown in June, after spinning a web and rolling the leaves together in a characteristic manner. There are 2 or more broods annually. This insect may be destroyed by spraying with arsenate of lead, 15 ounces to 80 gallons of water, in May, or with Paris green 1 pound to 150 gallons of water.

THRIPS (*T. tritici*) is a minute yellow insect with an orange tint on the thorax. The species is most injurious in the Southern States where it attacks the pistils of strawberries, causing a blighting of the ovaries. Other parts of the flower are also attacked to some extent, as well as the foliage. This insect is also injurious to a considerable variety of fruit trees and garden crops. Good success has been had from spraying with Rose Leaf Insecticide, whale oil soap or kerosene emulsion. The latter 2 remedies must not be used too

near the berry season, on account of the liability to impart a disagreeable flavor.

Tarnished Plant Bug (*Lygus pratensis*) varies in color from dark yellow to nearly black. It is a bug about 1/4 of an inch long, which sucks the juice from a great variety of growing plants. It is injurious in both the adult and immature stages. The species may be destroyed by dusting infested plants with pyrethrum or by spraying with kerosene emulsion.

White Grubs. These are the larvae of May beetles (*Lachnosterna fusca, etc.*). The adults, also known as June bugs, are recognized by their brown or black color and their habit of flying to lights at night. The common species is about 3/4 of an inch long. They remain concealed during the day and come out at night to feed on the leaves of trees. The eggs are laid in the ground and the larval existence extends over 3 years. The grubs are soft, white with a brown head. There are many species of them but it is not necessary to the present purpose to describe them.

White grubs attack a great variety of plants but are especially injurious to grasses, cereals, fruit trees and bushes, nursery stock, and greenhouse plants. These pests are destroyed by parasitic fungi, mites and other insects, and are fed upon by various birds and small mammals. The grubs may be destroyed by freezing of the soil and protracted drouth is unfavorable to their development. The best insecticides for use against the grubs in the soil are bisulphid of carbon and kerosene emulsion.

TEA

Tea as a beverage ranks second only to coffee in commercial importance. It has been cultivated in China since the dawn of history and in India since 1875 when the leaf blight of coffee forced the planters to turn from coffee to tea. In the Orient the plant thrives best under a rainfall of 90 to 200 inches a year. Tea is grown at all elevations from sea level to 7000 feet or more above sea level, as at Darjeeling, India. The higher the altitude at which it is grown the more delicate the flavor. For the highest grade of tea only the tip of the actively growing shoot and one or two of the youngest leaves are picked. There are about 10 to 25 pickings a year, every 10 to 12 days in Ceylon.

Several experiments with tea were made in South Carolina beginning about 100 years ago. Shortly before the Civil War more serious efforts were put forth to start a tea industry, with the result that in many localities in the Southern States a few tea bushes were grown in home gardens. These experiments showed that a good quality of tea could be raised in this country for home use, but that the crop had but small commercial prospect on account of the relative cost of picking

FLOWERS AND FOLIAGE OF THE TEA PLANT

and curing leaves as compared with the cheap labor cost in Oriental countries. Nevertheless tea is still grown in gardens near Summerville, South Carolina, and probably elsewhere in home gardens. The culture is not technically difficult and the advantage of having a tea supply in one's garden, when under war conditions no importations may be expected, is worthy of consideration. In addition to an abundance of moisture tea requires a climate where the temperature seldom falls below 25 degrees F. Tea plants, when once established, may continue to produce leaves for 50 years or longer.

TUNG OIL TREE (*Aleurites fordi*)

The Tung oil tree is a native of China and long known as the chief commercial source of fast drying wood oil. The tree attains a height of 30 feet or more, begins to bear at the age of 3 to 5 years, the fruit ripening in September and October, and each nut containing 2 to 5 seeds. The seeds contain about 53 per cent of oil and yield 40 per cent by pressure. Formerly as much as 15,000 tons of this oil annually were exported from Hankow. For about 30 years tung oil trees have been cultivated in the Gulf States from South Carolina to Texas and in Cali-

fornia. The tree will endure temperatures as low as 15 degrees F. and has been found to produce, in these States, a satisfactory quantity of nuts with an oil of good quality. A closely related tree, Kukui (*Aleurites moluceana*), covers about 15,000 acres in Hawaii, where the annual yield of nuts is 7 or 8 tons per acre. Candlenut oil is the trade name for the product of this tree. A century ago Hawaii exported 10,000 gallons of the oil annually but the industry has been allowed to lapse.

Tung tree leaves have been found to be deadly poisonous to cattle that browsed upon them in Florida.

WALNUT

Of the total domestic supply of all tree nuts Persian walnuts constitute about 35 per cent, nearly all of which are grown in California and Oregon. The development of commercial walnut growing is more recent in Oregon than in California. The average yield of nuts is about 500 pounds per acre. The labor required for walnut orcharding is about 60 hours per acre, ¾ being used in harvesting. With such a concentrated seasonal demand for labor the small orchardist is urged to diversify his farm operations with other crops so as to distribute the labor load more uniformly through the year.

Hill orchards as a rule produce only half as abundantly as orchards on valley and bottom land. But walnuts are susceptible to frost and freezing occurs more frequently on bottom lands than on hillsides. The improved varieties, Franquette among others, bear more than seedling trees even when 3 years younger. The use of cover crops in walnut orchards is gaining in favor.

The 3 species of walnuts commonly grown in the United States are the black walnut (*Juglans nigra*), butternut (*J. cinerea*) and Persian or English walnut (*J. regia*). The black walnut and butternut are native forest trees, growing from 50 to 75 feet high and valuable as timber trees as well as for the nuts they furnish. These trees are seldom cultivated for their nuts. The wild nuts are gathered and marketed to some extent by farmers. The trees have been grown at a number of experiment stations in forest plantations. They grow quite rapidly, frequently acquiring a height of 45 to 50 feet in 50 years, with a diameter of 8 to 10 inches.

Walnuts are propagated from seed. Nuts for seed should be harvested soon after they have fallen and planted at once or stratified in moist sand, left outdoors over winter and planted in the spring. Varieties true to name are obtained by root grafting seedlings with the variety it is wished to propagate. The native nuts grow best on heavy loam or alluvial soils. They are frequently found in greatest perfection along river bottoms. In California the English walnut is most successfully grown on well-drained, deep alluvial soils, and makes only a stunted growth on clays or soils underlaid with hardpan. The trees are set in the orchard when 1 or 2 years old 50 to 60 feet apart each way. The orchards are kept thoroughly tilled and irrigated. The nuts mature about September 1, when they are gathered, bleached and sent to market.

Enemies: BACTERIOSIS (*Pseudomonas juglandis*) attacks the leaf, branch and nut, and may be recognized by the blackening of affected spots which are surrounded by a water-soaked band. Hard shelled varieties are quite resistant and dormant trees may be protected by spraying with Bordeaux mixture.

TIGER MOTH (*Spilosoma Virginica*) is pure white with a few small black dots on the wings. It measures 2 inches across the wings. The caterpillars are yellow with a black head, and covered with hairs. The caterpillar is often known as the "yellow bear," and feeds on the butternut, grapevine, currant and other plants. When it occurs in large numbers it may be readily destroyed by spraying with arsenical poisons. The butternut is also subject to the attacks of scale insects, but these are seldom of economic importance.

WALNUT CATERPILLAR (*Datana angusii*) is the larva of a dark brown moth, with darker bands across the forewings, which have an expanse of nearly 2 inches. The eggs are laid in clusters on the terminal leaves, and the larvae devour all the leaf except the midrib. The caterpillars are gregarious, always feeding in clusters and migrating in colonies. When they undergo molting they crawl down upon the trunk and form a large mass. In this position they may be readily destroyed by crushing or by spraying with kerosene. Various birds feed upon the caterpillars, especially cuckoos and bluejays.

REGAL WALNUT MOTH (*Citheronia regalis*) is green with yellow spots on the wings. The larva has 4 stout forked spines near the head, 2 at the posterior end. It feeds on the leaves of the walnut, hickory and persimmon. It may be destroyed by hand picking or by spraying with Paris green.

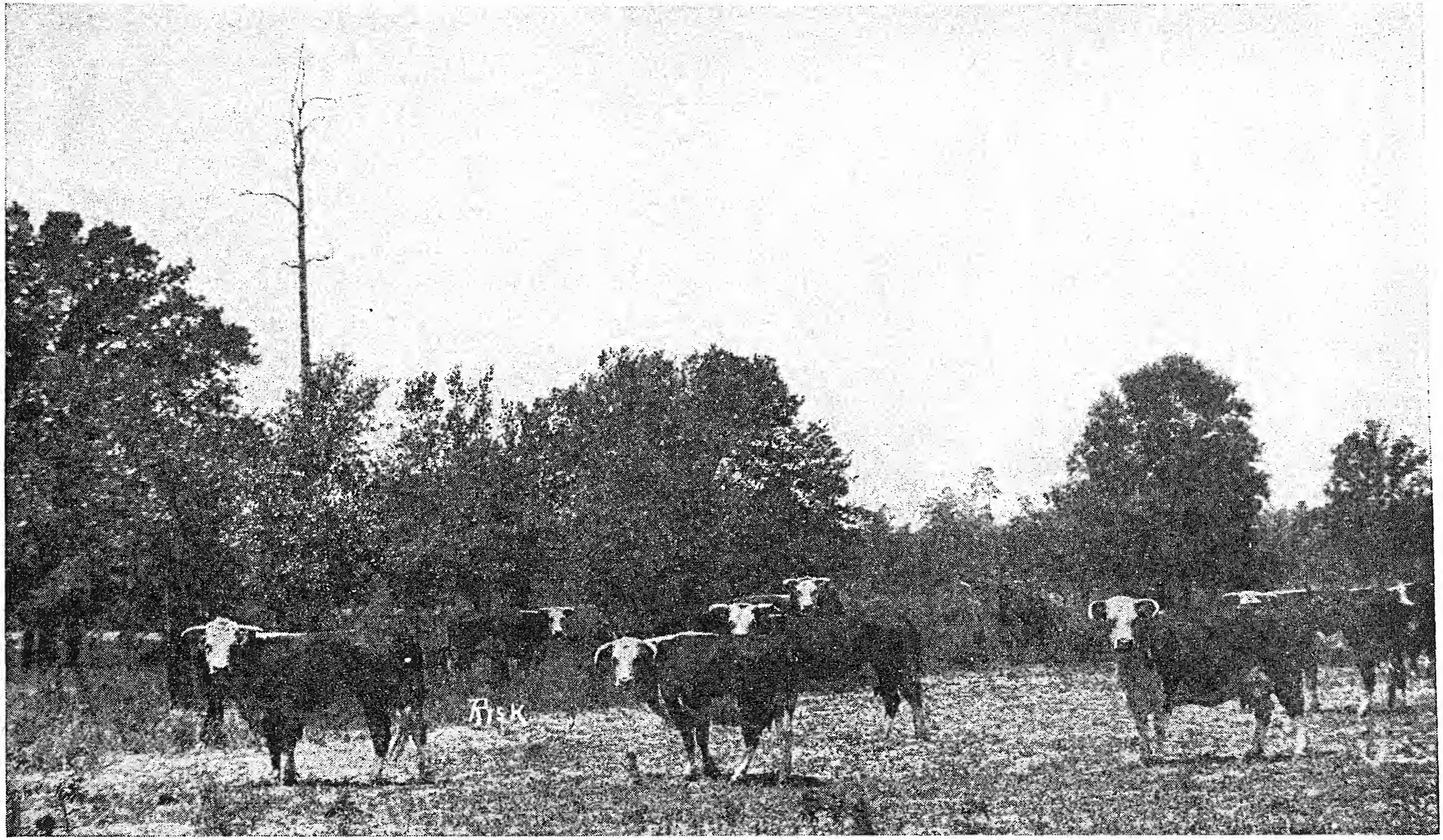
WINDBREAKS

Shelter belts or windbreaks are terms applied to belts of shrubs or timber planted on the windward side of orchards or fields for the better protection of crops. They are of especial value in the prairie States, where high winds are more or less constant, but are often of much service elsewhere, particularly in orchards, small fruit and garden culture. The special uses of windbreaks are to break the force of strong winds, protect crops from cold and prevent evaporation of soil moisture. Windbreaks may be harmful when they are so dense as to hinder the circulation of warm winds through them or when they are made up of such plants as are especially likely to harbor injurious diseases. Ordinarily in the Northern States 1 or 2 rows of deciduous trees will afford sufficient protection. Any of the rapidly growing native trees may be selected for this purpose. Where the winters are severe or the prevailing winds are high, thick evergreen screens may be highly beneficial. For this purpose the Norway spruce and Austrian and Scotch pines are especially valuable. The ideal shelter belt probably consists of a mixture of deciduous and evergreen trees.

In the Great Plains cottonwood, black locust, hackberry, bur oak, Osage orange, ponderosa pine, wild plums and choke cherry have proved serviceable in windbreak plantings. According to C. G. Bates: "How much of the farm area may profitably be devoted to windbreak protection must be determined by local conditions. In the Corn Belt, even toward its western edge, and certainly on valley and irrigated lands, the direct crop benefits from windbreaks will justify belts of a width fully equal to their ultimate heights. If these are planted 20 heights apart, approximately 5 per cent of the area can be used for trees without actually reducing farm yields. The planting of 10 per cent of farms to trees in the Middle West may not be too high a goal, but may possibly go beyond the point of highest returns."

PART IV

BEEF CATTLE AND DAIRYING



HEREFORD HERD IN KANSAS

BEEF CATTLE AND DAIRYING

DOMESTICATION

The **Domestication of Animals** is an important factor in the development and civilization of man. Before man had animal associates he was a savage, without a home, without cultivated fields and without sympathetic instincts. Animals, however, have produced more profound changes in man's mental and moral equipment and in his social and domestic affairs than any other feature of his environment. Animals not only furnished the power to subdue nature, cultivate the soil and inaugurate an agricultural system, but they also supplied food, clothing and many necessary utensils. The races which have few domesticated animals have remained far behind in point of power, commercial progress and mental development.

A human being without a fondness for animals is a rare and strange creature. A bond of sympathy exists between us and our animal associates and this sympathy has led to the establishment of various forms of association between man and animals. Many species of animals have found how to profit from association with man. We in turn have found it necessary as well as a source of satisfaction to utilize animals for our own purposes.

From thousands of species of animals on the globe only a few have been domesticated. At first thought this may seem strange but practically all of the really promising species have been domesticated,—most of them before the dawn of history. Man requires certain characteristics in his farm animals—the ability to understand and willingness to do his desires. Farm animals are useful to the extent to which they fulfill these requirements. A balky horse or one with vicious habits is of little or no value although his strength and speed may be of the highest standard.

Animal Characteristics. Perhaps we have not all realized how necessary it is to have an understanding between ourselves and our animal servants. But everyone has noticed differences in attachment. With the dog, home is at his master's side. His attachment is a personal matter. The dog, moreover, makes great progress in understanding his master's business and desires. We have all seen dogs which knew just where the pigs and chickens were allowed to range and where they were not permitted. All of us who have seen trained sheep dogs work know how attentive they are to their business. The coyotes and other enemies must be driven away. None of the sheep can be permitted to stray away from the herd. Sleeping lambs must be roused and driven into the herd when it moves away from the bed-ground. These and a hundred other details are attended to without any admonition from the shepherd. All this requires a high order of intelligence,—more than some of our human servants manifest.

Cattle show less of the personal element in their association with man. Usually they are perfectly content when they have comfortable quarters and enough to eat. One cannot help noticing, however, how differently they behave in the presence of strangers than with their regular attendants. A change of milkers produces a loss in milk yield. The cows are worried by strangers.

In a much greater degree the horse understands our desires and forms close personal attachments. The horse knows instantly when a stranger has the reins and soon learns whether it is safe for him to "soldier." Our horse remembers kind acts and also cruelty. He knows, too, whether or not we are likely to enforce our orders.

The domestication of animals implies a sort of contract. It is not a one-sided affair. The animal on his part agrees to fit in with the schemes of man and further his purposes by doing the appointed tasks. In return for these services man is under obligation to protect his animal associates from cold, heat, flies and storms; to furnish them suitable rations; and to give them sanitary quarters. The domesticated animal is a servant and the servant has rights. The man who beats or otherwise maltreats his stock is not only a brute but a fool from a mere business standpoint. If you abuse your farm animals you get less wool, less mutton, less pork, less beef, less milk, and less

work. This is one case in which money and decency are on the same side of the scales.

Proper Sanitation. The same may be said of farm hygiene. Animals require sanitary quarters. Yet who has not seen farm stock in stables quite without ventilation, with moisture dripping from the walls and full of filth and foul odors? Under such conditions stock cannot thrive or produce a profit for the owners. Moreover, animals have the right to healthful surroundings. In becoming servants of man they gave up the freedom which enabled them to secure plenty of fresh air, untainted food and a clean bed-ground. Anyone can readily convince himself that farm animals are naturally of cleanly habits and, if a choice is offered, will not voluntarily lie in filth or eat soiled food. It is an easy matter to encourage and strengthen this tendency. By so doing we serve the interests of the farm stock and our own pocketbooks.

Important Live Stock Problems. To the student stock raising offers as interesting and as difficult problems as any other line of life work. The world has long worried over the various questions of heredity and variation. These can best be solved by working on domesticated animals. The average farmer can easily keep a record of his animal breeding which will be of the utmost value. He has to learn how to produce more fat or more lean, large bones or fine bones, long or short legs, long or short snout, fine, delicate ears, the proper expression in the eyes, smoothness and regularity of form, a well-balanced development, the deposition of fat in certain parts of the body, a marbling of the meat, strength and elasticity of bone, delicacy of skin, a certain fineness and length of hair, definite color and definite color patterns, feather markings, size, color and form of comb, wattles, legs and other parts, lung capacity, temperament, strength, vigor, action, ability to transmit desirable qualities to offspring, and so through the list of the many points which have been attained by breeding.

The great strides already made along this line have not been accomplished by accident or by luck, but by working with a definite purpose in mind; not by leaps and jumps, but slowly through patient toil and after numerous failures. To the originator of a new, useful breed of animals the world owes as much as to the inventor of the most useful mechanical device. These men, however, are little known and little appreciated. All school children are taught who invented the telephone, telegraph, steam engine, locomotive, etc. How many of our readers know the names of men who contributed to the origination and substantial improvement of Shorthorn, Hereford, Angus, Holstein, or Jersey cattle; modern types of horses, mules, zebroids; Berkshire, Duroc-Jersey, Yorkshire, or Tamworth hogs; Rambouillet, Southdown, Dorset, Suffolk, Lincoln, Cotswold or Cheviot sheep; Wyandotte, Dorking, Plymouth Rock, Orpington, Minorca, Brahma or Houdan chickens; and so on through the almost endless list of distinct and valuable breeds of farm animals and fowls?

These improved breeds have contributed untold wealth, comfort and enjoyment to the human race. In order to appreciate this point more fully compare the modern Berkshire hog and the "razorback," the Shorthorn and the Texas steer, the broncho and the thoroughbred, the common goat and the Angora, the tough unimproved fowl and the Wyandotte. Breeders have made improvement in every direction—in the quality and flavor of the meat, in the value of the wool and mohair, in the size of the animal, in speed, strength and endurance of the horse, in docility, fertility and the power to utilize feed stuffs economically.

This sounds formidable enough on paper and in practice it is more difficult than it sounds. There is the constant struggle to prevent undesirable characters from cropping out in your farm animals. The process of improving animals is in one sense unnatural or somewhat against nature. Certain natural tendencies have to be overcome, others greatly developed. The sheep's coat is a protection and great comfort in winter. By careful selection, however, we have so increased the weight of the fleece that in warm weather it is a positive burden to the sheep and must be removed once or twice a year. Without man's intervention nature would gradually reduce the amount of wool.

Another example of this sort is seen in milch cows. Native cattle have small milk glands and produce a quantity of milk barely sufficient to nourish the calf for the first two months of its life. We have increased the size of the gland and the milk yield enormously until good dairy cows yield 6500 to 30,000 pounds of milk per year. This is, again, an unnatural performance and can be maintained only by rigid selection.

In the hog, in turn, we have taken advantage of the tendency to lay on fat and have developed it to such an extent that the hog has become a living fat factory.

Similarly through the list of breeding achievements we have exaggerated certain tendencies and suppressed others until the breeder must be constantly on the alert to maintain the high standard in his stock. Under natural, wild conditions there is no occasion for the production of a 10 pound fleece, a 30,000 pound milk yield or 200 pounds of fat, and if left to themselves, such animals would soon return to the normal wild condition.

The animals themselves take no conscious part in the improvement of breeds. In fact from their standpoint what we call improvements may not be improvements at all. Animals can certainly derive no advantage to themselves from becoming so fat that they cannot walk without danger of crushing the bones of the leg, from producing a fleece too hot and heavy for comfort, or from producing three times as much milk as is needed for their offspring. These conditions must be brought about by man without help from the animals, for our farm stock can hardly be expected to take interest in a process which tends in some respects toward their discomfort.

The unconscious forces of nature also operate against us because we make our animals do or produce more than would be necessary in a state of nature. In the natural laziness of things there is great inertia against doing any unnecessary work. Enormous milk yields and increased production of other animal substances constitute a more or less serious drain on the strength of the animal. Their health is liable to be affected and special diseases arise.

The difficulties have been overcome as they arose and it is therefore unnecessary to consider them further. They should remind us again of our debt of gratitude to the men who have given us our modern wonderfully perfect farm animals.

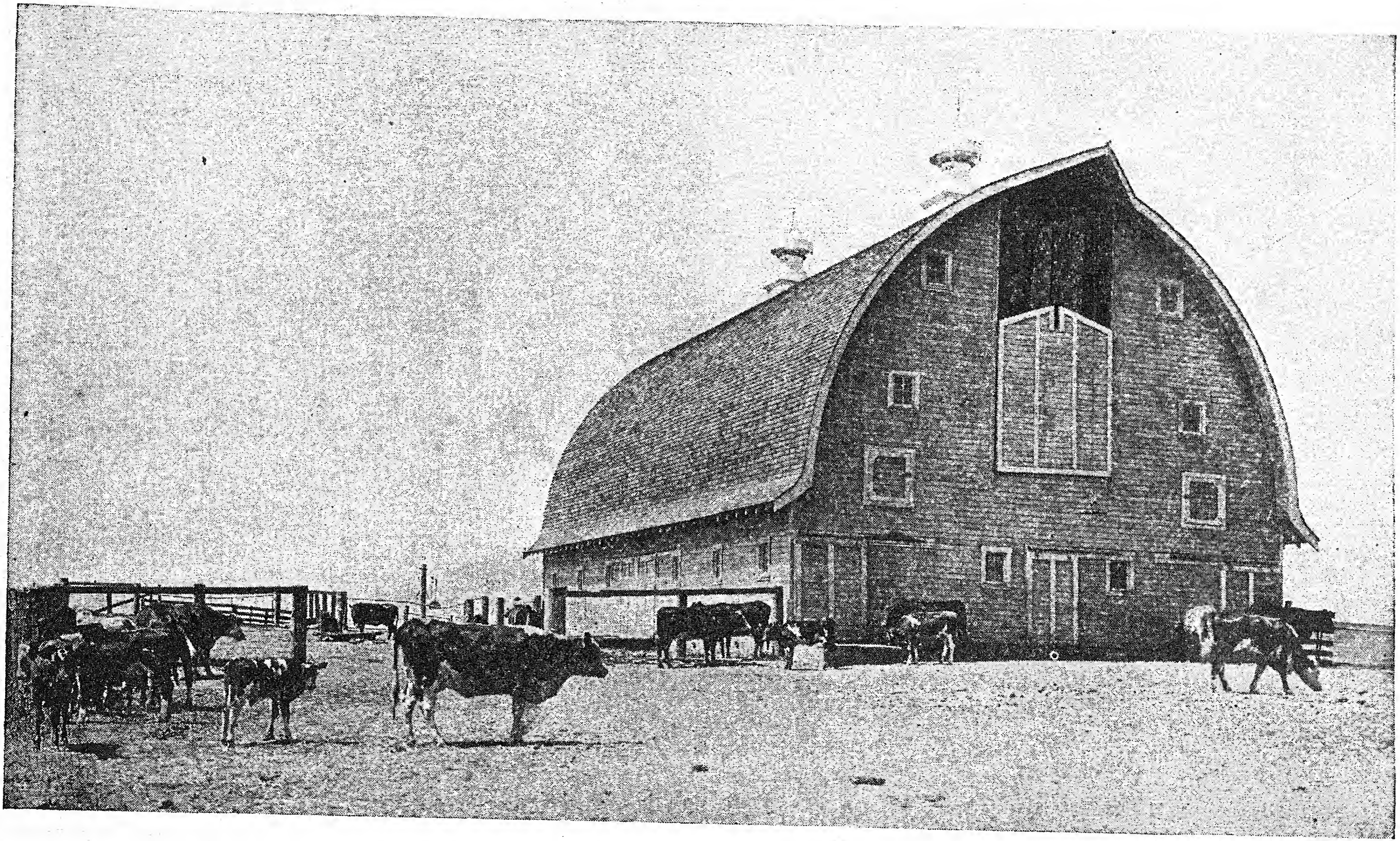
A farm without live stock is an incomplete idea. Fields of alfalfa, clover, rice, sugar cane, cotton; orchards of cherries, peaches and oranges may be beautiful but they soon become tiresome to the eye if no farm animals are in sight. The well-sodded, green pasture supporting cows, sheep, goats and horses is required to round out the idea of farm or homestead.

Nor only from an artistic standpoint is home incomplete without animals, but also from a business standpoint. It is impossible to sell all crops as such to the greatest advantage. Without farm animals there is always considerable waste on the farm. Small undersized potatoes must be thrown away. Turnips, rutabagas, carrots, cabbage, cull apples, etc., are allowed to rot and become a total loss. Animals manufacture meat, milk, wool and eggs from this unsalable material. Hogs will root out and eat all potatoes that may have been missed in digging. They will also harvest other root crops and will pick up a good living from the shattered grain left on the ground after harvest. Sheep clean the weeds out of fence corners better than hired help. All this work is done without expense, and much material which otherwise would be lost is utilized.

There is another practical point worth bearing in mind. Farm crops are bulky and require much time and labor for transportation to market. Moreover, they are in a comparatively raw, crude condition. In the finished product—meat, milk, eggs, wool, etc.—the crops bring more and are more easily marketed. Many farmers keep their men and teams busy all fall and winter long hauling hay and corn to market. The same hay and corn could be made into beef and pork on the farm and marketed in a day. This allows the men and teams as well as the farmer himself to remain on the farm and attend to their proper business. The fences need repairing, a few broken hinges are to be replaced and definite plans must be made for the next year's work. The whole farm should be carefully mapped and crops assigned to each field for a period of five years in advance. Such plans require thoughtful attention each year. It is good work for the fireside in winter and serves to keep the farmer at home rather than constantly on the road between the farm and town.

This is no place or occasion to set forth the importance of meat in the human diet. This is too well known by the millions who eat it. A corner on meat causes unspeakable anxiety and even panic among the people. The working man must have meat. Without going into the merits of the vegetarian controversy, meat is indispensable to most of us if we are to remain capable of normal work.

Then, as already indicated, the articles of clothing and manufacture furnished by animals are beyond number. Our debt to animals is large but we must make it still larger by greater animal production.



CATTLE BARN AND FARM HERD

Qualifications of a Stock Farmer. The stock raiser must know the laws of heredity, the principles of breeding, animal physiology, the nature and treatment of diseases and practical hygiene. This involves some engineering skill in providing water supply and drainage. Then he must know the chemistry and effect of foods. Brains and skill in feeding bring results and save money.

Stock Raising a Science. The man who understands the principles of feeding and the nutritive value of feeding stuffs will be able to compound rations for mere maintenance, for growth, for fattening or for other special purposes. Stock farming is not a trade but a science combined with practical skill. The brain work is far more important than the manual labor.

Farm soils are not inexhaustible. Removing crops year after year is like drawing checks against your bank account. When the account is exhausted in either case you can draw no more. Now, the ideal way of cropping the soil annually is to carry farm animals up to the limit of the farm's capacity and raise legumes, which in turn are effective in stock feeding as well as in maintaining the fertility of the soil. When the farmer hauls his hay and grain to market he is hauling away his farm, but when the annual surplus of farm animals is sold the farm and its fertility remain.

A very important requisite of the successful stockman remains to be mentioned. There must be a liking of the business and a love of animals. The farmer need not be fond of all kinds of live stock. In fact strong prejudices may exist against sheep, hogs or some other animal simultaneously with a special fondness for horses or cattle. Cattlemen may hate the sight of sheep and sheepmen of cattle. The successful stockman, however, is fond of his animals. He has names for all of them. He knows all their peculiar habits, when they sleep, when they drink, what and how much they eat. He therefore recognizes instantly when one of his animals is "off feed" or ailing in any way and promptly attends to its wants. In other words he knows his stock as individual animals, not as a herd. The peculiar requirements of each animal are thus considered in farm practice. Farm animals differ as much in temperament and habits as man. In the same herd very different dispositions are to be observed. When these differences are taken into account in the rations and daily treatment of different animals the best results are obtained.

Farm animals must continue to furnish us with food, clothing and many other necessities, and our indebtedness to them will increase rather than diminish. There is accordingly a glorious opportunity for all stock raisers to improve the quality of their animals and an equally fine opportunity for the great extension of the business to meet the ever-increasing demand for animal products.

CATTLE

The importance of the cattle industry is too well understood to require any comment. According to the latest statistics the total number of cattle in the United States is 74,607,000 of which 48,304,000 are beef cattle, and 26,303,000 dairy cattle. About 2 million of the beef cattle are purebred, the breeds standing in the order Shorthorn, Hereford, Aberdeen-Angus, Galloway and Devon, in greatest numbers in Iowa, Texas, Missouri, Kansas and Nebraska.

While cattle-raising constitutes an important part of agriculture in every State, the business is conducted on the most extensive scale in Texas, Iowa, Wisconsin, Minnesota, Kansas, Nebraska, Illinois, Missouri, Oklahoma, California, New York and Ohio, mentioned in the order of their importance, and other States of the Western range region and Northern boundary.

All our domestic breeds of cattle are supposed to be derived by improvement and crossing from 2 original wild species of cattle. The breeds of cattle in the United States were introduced from Europe, mostly from Great Britain.

Cattle are usually classified according to their form or conformation into 3 types: beef, dairy and dual-purpose. The general characteristics of the beef type are: compact form; medium length; wide, straight back; deep, full quarters. The outlines are those of a parallelogram, and the form is rounded. The general outlines of the dairy cow form a wedge-like figure. The length is greater, the contour of the head and neck thinner, and the udder and milk vein well developed. The body is more angular and the temperament more nervous. The characteristics of the dual-purpose animal are intermediate between those of the beef and dairy types.

Breeds. The chief beef breeds in this country are Shorthorn, Hereford, Aberdeen-Angus, Galloway, Sussex and West

Highland. The principal dairy breeds are Ayrshire, Holstein, Jersey, Guernsey, Dutch Belted, French Canadian and Kerry. Among dual-purpose cattle the Shorthorns stand at the head. This class also includes Polled Shorthorn, Red Poll, Devon, and Brown Swiss.

A few of the chief beef and dual-purpose breeds may be briefly characterized here. For dairy breeds *see* under *Dairy Farming*.

This matter, however, depends so greatly upon the opinion of breeders, who are usually somewhat prejudiced in favor of one breed or another, that the point is hardly worth arguing. Shorthorns seem especially suited to the Central States where good pastures prevail and grain for fattening is abundant. On account of their high milk yield they are often classed as a dual-purpose breed. There is a special strain of milking Shorthorns.

SHORTHORNS ON THE RANGE

SHORTHORNS also called DURHAMS were brought from England to America about 1785. This is perhaps the most widely distributed and popular breed of cattle. They are raised in every State and in every Province of Canada. Shorthorns readily adapt themselves to different conditions, are relatively large and mature early. They are good feeders, fair grazers, the meat is of excellent quality and the milk production is large. They have a large, rectangular, but smooth, symmetrical form. The color is red, roan or white. Red is preferred, while white is not in favor. In point of hardihood they are not equal to the Galloways or Scotch Highland cattle, and are probably inferior in this respect to the Herefords under western range conditions. The Polled Shorthorn, formerly called Polled Durham, developed in Ohio and neighboring States, from Shorthorn bulls and muley cows is really a Polled Shorthorn and resembles Shorthorns closely in all points except horns.

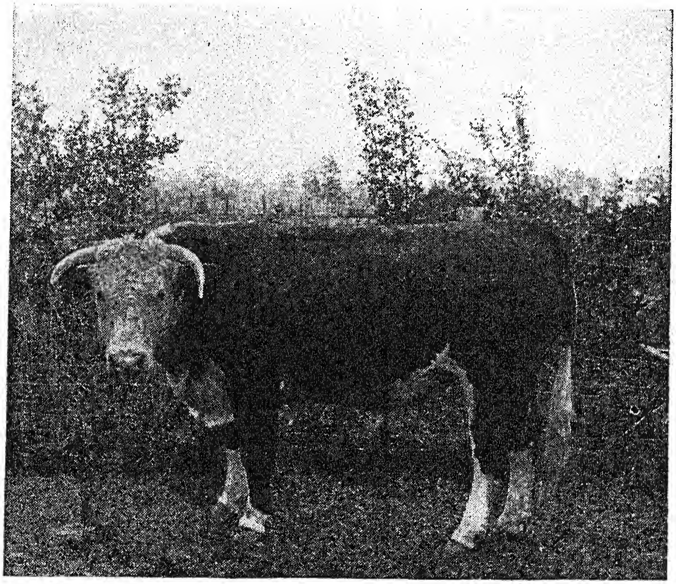
HEREFORDS are believed to have been first imported into the United States by Henry Clay in 1817. They mature as early as the Shorthorns and are nearly as large. They are probably superior to Shorthorns in quality of meat and in grazing and breeding properties. They are nearly equal in adaptability, but produce less milk than Shorthorns. The ground color is a rich red, with white face, legs, under part of body and tip of tail. They have lighter thighs, thicker skin, more spreading horns and more curly coats

than the Shorthorns. Herefords mature early and make good crosses with Shorthorns and Galloways.

POLLED HEREFORD. While the horns of the Herefords were always considered one of the elements of beauty of that breed the market demand for polled cattle led to the origination of the polled form of the breed by crossing Hereford bulls on common muley cows. There is no tendency for the horns to return. The breed is distributed from Wisconsin to Texas.

Western ranges and in Alaska. Crossed with the American bison they produce remarkably fine and valuable robes.

The DEVON is one of the oldest breeds of English cattle and was first brought to America in 1817. Devons are inferior to Shorthorns in size, adaptability, maturing and feeding qualities. They are about equal as milkers and the quality of the meat is very superior. They are of active habits and are good grazers. The general color varies from a rich red to a pale chestnut, with no black or white except a white spot on or in front of the udder. The horns on the female are slender, creamy white and curved upward. The milk is very rich, but the quantity is small. Devons make very serviceable draft animals, and in Hawaii have proved well adapted. The dates given for the importation of this and other breeds are those of the first introduction of a herd to which records can be traced in this country. Undoubtedly earlier importations were made.



HEREFORD SIRE

The ABERDEEN-ANGUS originated in Scotland and was first brought to the United States in 1873. They are raised most extensively in Iowa and Illinois. The breed is growing in popularity. They are perhaps not so well adapted to range conditions as the Herefords or Shorthorns. They are but little smaller than the latter and mature almost as early (at about 30 months). They are good feeders and the quality of the meat is superior to that of Shorthorns or Herefords. Their milking properties are somewhat inferior.

GALLOWAYS, like the Angus, came from Scotland. They were introduced into Michigan in 1870. They are black and polled, differing from the Angus chiefly in their unusual hardiness on the range and in severe climates, and in their coat of thick, soft, wavy hair with a mossy undercoat. They have given satisfaction on

BROWN SWISS cattle were introduced from Switzerland into Massachusetts in 1869. They are a dual-purpose breed of medium size, dark to light brown or gray. Milk is of good fat content, moderate in quantity.

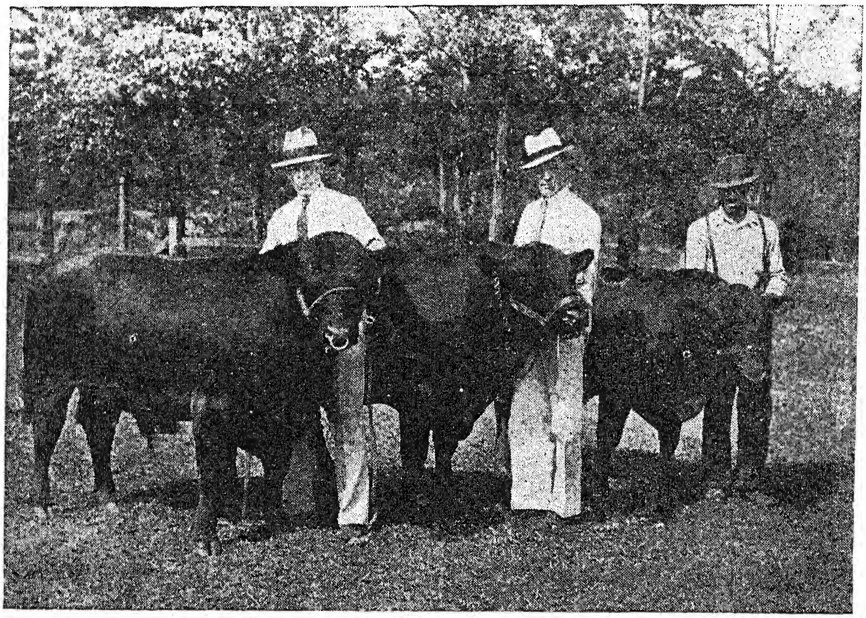
RED POLLED cattle stand between Shorthorns and Devons in size, are excellent

milkers and mature early. They are popular dual-purpose animals, distributed mostly in the Mississippi Valley.

Brahmans or Zebus, also known as Indian cattle, are used in India for milk and work. They are characterized by a prominent hump over the shoulders, loose pendulous skin under the throat and on the dewlap. The ears are large and drooping. Hair is rather sparse, hide thick and relatively free from ticks. The Brahmans are practically immune to Texas fever and endure hot weather well. Distribution from New Orleans to Brownsville, Texas.

Africander cattle were introduced into Texas from South Africa in 1931. The horns droop downward or point backward. The hump is rounder than that of the Brahmans. The Africander is exceptionally hardy, of a dark red color, adaptable to poor feed and inclement weather.

Breeding Qualities of Different Breeds. It is generally believed that so-called beef breeds are better for beef production than dairy breeds or scrubs. The reasons given for this superiority, however, are often incorrect. A comparison of breeds at the Michigan Station showed no constant differences in meat production among beef breeds. Dairy breeds made poorer gains, laid on more fat around the internal organs, showed more shrinkage and a higher percentage of cheap parts than beef breeds. The latter also matured earlier. In Missouri the Shorthorns stood first in power of beef production and in quantity of fat. Angus was first in palatability of meat and in all around excellence, followed by Shorthorns, grades and Herefords. All pure breeds and grades proved better than scrubs. In North Carolina, however,



ANGUS PUREBRED SIRES

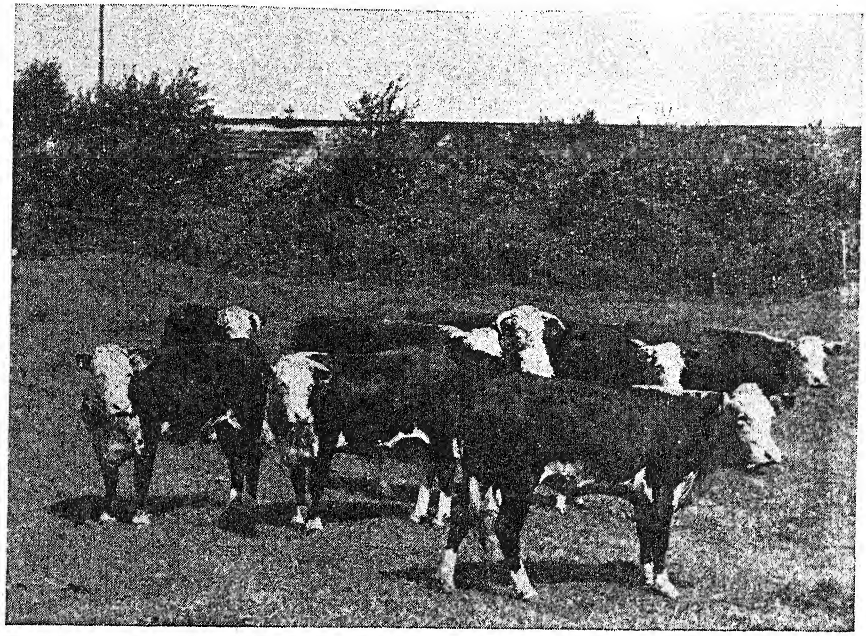
scrubs proved more profitable than grades on cottonseed meal and hulls. At the Minnesota Station no constant differences were found in the fattening qualities of grades from different breeds. Angus and Shorthorns proved equally good at the Iowa Station. In Kansas Shorthorns were slightly superior to scrubs in economy of gain and percentage of dressed weight. Native steers did better than pure breeds in Utah. At Toronto no differences were noted in beef qualities of pure breeds, but good grades made better gains than scrubs. Holsteins proved superior to Shorthorns and Herefords in Maine.

The experimental comparison thus fails to show that 100 pounds of gain can be produced with less feed by beef breeds than by dairy breeds, grades or even scrubs. Nevertheless, there are good and sufficient reasons for choosing beef breeds

for the production of beef. Beef breeds lay on fat in the best cuts of steak and roasts on the back, while the dairy breeds accumulate fat around the internal organs. Tallow may constitute as much as 32 per cent of the carcass of a Jersey steer. The contour of such animals remains angular when they are fattened and they bring a smaller price on the market.

Much speculation has been indulged in concerning the factors which determine sex, and numerous theories have been proposed, which cannot be discussed here. Suffice it to say that none is perfectly satisfactory. At the Maine Station 82 cows served during the first part of heat produced 31 bulls and 51 heifers, and 76 cows served in the last part of heat produced 42 bull and 34 heifer calves. There are other experiments at variance with these results, and no conclusions can be drawn regarding the influence of the time of service upon the determination of sex. Statistics compiled on 3614 calves do not substantiate any theory of sex determination. Some cows show a tendency to produce bull calves, others heifers and still others twins. Of 3614 calves, 62 were twins.

The microscopic study of the nuclear composition of the reproductive cells, sperm and ovum, has disclosed the fact that the sex of offspring is determined at the time of union of these two cells and cannot be changed or influenced by the relative vigor or age of parents, or by any prenatal event or treatment. Sex is irrevocably determined by the chance union of unpaired chromosomes in the male and female reproductive cells, and



HEREFORDS IN NEW JERSEY

Period of Gestation and Other Physiological Data. The average duration of pregnancy in cows is 285 days, the extremes being 240 and 336 days. Bull calves are usually carried a few days longer than heifers. In young heifers and very old cows the period is often shorter than the average. At the Maine Station the average was found to be 282 days for bull and heifer calves. The weight of calves at birth varies from 50 to 130 pounds. At the Maine Station the average weight was found to be 73.6 pounds, the average weight of bull calves being 76.8 pounds, and of heifers 70.1 pounds.

Having determined upon the time of the year calves are desired one need only refer to the following convenient table, prepared by the U.S. Bureau of Animal Industry, to learn when the cows should be bred.

can neither be regulated nor predicted by man.

The normal temperature of adult cattle is 101° to 102° F. It may be somewhat elevated by exercise or lowered by large drafts of cold water or exposure to cold. Fever temperatures in cattle range from 103½° to 106° F., or higher. The temperature should be taken by inserting a thermometer into the rectum and allowing it to remain for 3 to 5 minutes. The pulse rate is 45 to 50 times per minute.

Calves. Several systems of raising calves are in vogue among different stockmen. The calves may be allowed to run with the cows and suck at will. They may be confined and allowed to suck 2 or 3 times per day. In this system one calf may be allowed to suck 1 or 2 cows, or 2 calves may be allowed to suck the same cow, according to the flow of milk and size of the calves. Calves may also be confined and fed fresh whole milk from the pail. Again they may be fed on fresh skimmilk or separator milk, or on sour skimmilk, or even buttermilk or whey.

On the Western ranges, and in other localities where beef is the chief object, and where the milk is not desired for other purposes, the calf is allowed to run with the mother. Under range conditions this is the only possible economic way of raising calves. The sucking calf develops into a more promising yearling than the skimmilk calf, especially if the latter is fed in a careless and irregular manner. Without proper care skimmilk calves make small, pot-bellied yearlings, which in the Western States are known as "dogies."

Wherever cattle are raised on a small scale and there is a good market for milk, it does not pay to let calves suck the cows. Only calves which will bring fancy prices for breeding purposes can profitably be allowed to run with the mother. Milk will bring a larger price as butter than ordinary calves can make from it.

The results of numerous experiments in the United States and Canada are in substantial agreement with regard to the most economic method of raising calves. They should be allowed to suck the cow for 3 or 4 days. They will thus get the colostrum or first milk and exercise a favorable influence in preventing inflammation of the udder. About the fourth day the calves should be separated from the cows and fed on whole milk by means of an artificial feeder, or taught to drink

Gestation table for cows (283 days)

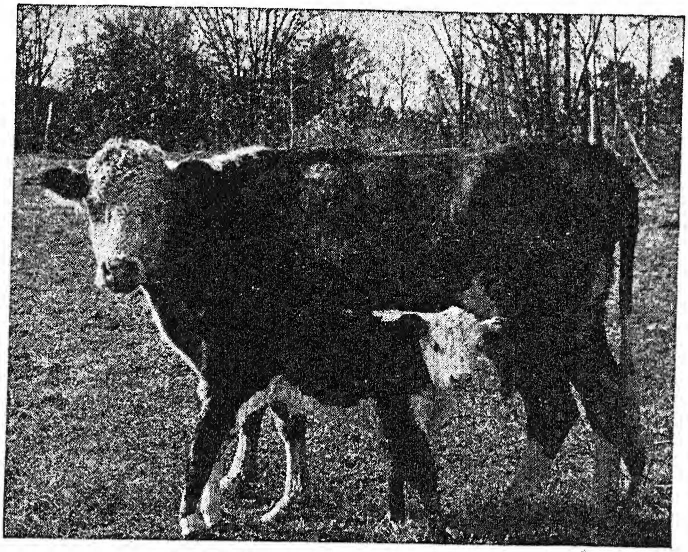
Day of month bred	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Explanation: Find date cow was bred in first column and month bred in top line. The date in column below opposite date bred will be the time at which the cow is due to calve											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	11	11	9	9	8	11	10	11	11	11	11	10
2	12	12	10	10	9	12	11	12	12	12	12	11
3	13	13	11	11	10	13	12	13	13	13	13	12
4	14	14	12	12	11	14	13	14	14	14	14	13
5	15	15	13	13	12	15	14	15	15	15	15	14
6	16	16	14	14	13	16	15	16	16	16	16	15
7	17	17	15	15	14	17	16	17	17	17	17	16
8	18	18	16	16	15	18	17	18	18	18	18	17
9	19	19	17	17	16	19	18	19	19	19	19	18
10	20	20	18	18	17	20	19	20	20	20	20	19
11	21	21	19	19	18	21	20	21	21	21	21	20
12	22	22	20	20	19	22	21	22	22	22	22	21
13	23	23	21	21	20	23	22	23	23	23	23	22
14	24	24	22	22	21	24	23	24	24	24	24	23
15	25	25	23	23	22	25	24	25	25	25	25	24
16	26	26	24	24	23	26	25	26	26	26	26	25
17	27	27	25	25	24	27	26	27	27	27	27	26
18	28	28	26	26	25	28	27	28	28	28	28	27
19	29	29	27	27	26	29	28	29	29	29	29	28
20	30	30	28	28	27	30	29	30	30	30	30	29
21	31	Dec. 1	29	29	28	31	30	31	July 1	31	31	30
22	Nov. 1	2	30	30	Mar. 1	Apr. 1	May 1	June 1	2	Aug. 1	Sept. 1	Oct. 1
23	2	3	31	31	2	2	2	2	3	2	2	2
24	3	4	Jan. 1	Feb. 1	3	3	3	3	4	3	3	3
25	4	5	2	2	4	4	4	4	5	4	4	4
26	5	6	3	3	5	5	5	5	6	5	5	5
27	6	7	4	4	6	6	6	6	7	6	6	6
28	7	8	5	5	7	7	7	7	8	7	7	7
29	8	....	6	6	8	8	8	8	9	8	8	8
30	9	....	7	7	9	9	9	9	10	9	9	9
31	10	....	8	....	10	....	10	10	....	10	....	10

whole milk from a pail. As soon as they have learned to drink the whole milk should be gradually replaced with warm, sweet skimmilk, so that the calves are receiving nothing but skimmilk at the end of 4 weeks. The skimmilk should be fed sweet and warm (95° to 100° F.). The change from whole milk to skimmilk should cover a period of about 2 weeks. Two teaspoonfuls of codliver oil per day may be added to replace vitamin A in whole milk. The skimmilk ration may begin at 10 pounds per day and increase to 15 pounds at 4 weeks of age, after which it may range from 18 to 24 pounds.

Artificial feeders are usually unsatisfactory. It is better to teach calves to drink by using the fingers. Scouring in calves is usually due to feeding too much milk, or sour, cold or unclean milk. Careful attention should be given to these details. If scouring persists, the calves may be fed small quantities of wheat bran or rye bran, or a little lime may be added.

For their best development calves require milk for 4 or 5 months. After that time milk may be omitted from the ration. Small quantities of grain should be fed from the time the calves are 2 or 3 weeks old. Corn meal, Kafir corn meal, oatmeal and ground flaxseed or linseed meal are best for this purpose. Calves may be taught to eat by placing a handful of dry meal in the mouth.

At the Iowa Station the use of whole milk resulted in slightly better gains than skimmilk and flaxseed. The skimmilk calves, however, were less checked in their growth by weaning than were the whole milk calves. Cost of gain on full milk was 7.6 cents per pound, on skimmilk and flaxseed 5 cents per pound. In later tests corn meal proved best of all grains for this purpose. When fed dry after each feed of skimmilk it reduced the cost of gain to 2 cents per pound for a 90 day period. A little clover hay was fed at the same time.



HEREFORD COW AND CALF

At the Nebraska Station similar results were obtained. At the end of a year whole milk calves could not be distinguished from skimmilk calves, and the profits were much greater in the latter than in the former.

In Minnesota the cost of raising calves on whole milk was 3 times that of raising them on skimmilk and ground flaxseed. An emulsion of skimmilk and oleomargarine with the addition of brown sugar gave good results in Massachusetts. When pork was high and veal low, however, calves did not give as good returns from skimmilk as pigs. At the Indiana Station calves made profitable gains on skimmilk alone.

The Kansas Station recommends that skimmilk be sterilized at a temperature of 212° F. Calves which received 12 quarts skimmilk per day with a small

quantity of Kafir corn meal made as good gains as on whole milk.

At the Pennsylvania Station milk gave better returns in veal than in butter. In Utah calves up to the age of 3½ months required less milk and grain for a pound of gain than pigs, but after 5 or 6 months they require more than pigs. In Wisconsin curds obtained from sweet skimmilk by heating it to 90° F. and adding liquid rennet extract gave excellent gains in calves. The Toronto Station found that skimmilk was no longer indispensable after 2 months.

In Mississippi cottonseed was found to be the cheapest grain for calves. If fed in too large quantities, however, it may kill them, as reported by the North Carolina Station.

This system of calf raising has been thoroughly worked out in Europe also. In France it was found that potato starch, cooked flaxseed, rice flour, barley meal, malt flour or oleomargarine could be added to a skimmilk ration with profit. Linseed meal proved superior to bran. Similar results were obtained in Holland, Sweden and other countries. In Sweden it was found that less diarrhea developed when an artificial feeder was used than when milk was fed from a pail. Recent experiments in Pennsylvania show that prime dairy calves can be raised without milk except for the first 2 weeks. A good milk substitute was found in a mixture containing wheat flour, cocoanut meal nutrium, linseed meal and dried blood.

The essential points in creep-feeding calves on Oklahoma farms are that the calves should be early. The November, December, January or February calf will prove the most satisfactory for creep-feeding. The calves should be taught to eat grain before they go to grass. Close attention to details is absolutely necessary in creep-feeding. High quality feed must be available in the feeder at all times. Feed spoiled by rain must be removed promptly or the calves will scour and go off feed. The creep should be located at the right place in a suitable pasture. The most suitable pasture will be one in which the cows have some common loafing place where the creep may be placed.

Early Maturity, "Baby Beef." Under certain circumstances, especially where dairying is combined with beef making, there is considerable advantage in securing early maturity or "baby beef." This problem has received much attention in Iowa, Kansas, Minnesota, Michigan, Wisconsin, Nebraska, Utah, New Hampshire, Colorado and Canada. The amount of feed required for a given gain is less in young than in old animals, and this fact often makes it desirable to begin forcing the animals from an early age. Scrubs do not mature so early as well-bred cattle and only the latter should be chosen for the production of baby beef.

The best plan for securing early maturity is to have the calves come in the fall. They may then be fed on skimmilk and grain until the pastures are green in the spring, when they should be turned to pasture with a daily grain ration. When the pasture gets short in the fall the calves may be taken up and forced on hay and grain to the age of 16 or 17 months.

In New Hampshire the total cost of bringing animals to a fine market condition at the age of 16 months was $28.81 per head. In Michigan it was found the early maturing breeds could perhaps be sold at most profit at 1 year of age if pushed from the start. In Colorado calves from 7 to 10 months of age were forced with good profit for 178 days on a ration containing corn, oats, sugar beets and hay. The Iowa, Nebraska and Minnesota Stations have shown that a combination of dairying and beef production may be made very profitable. Dairy Shorthorns give good returns in milk, and steers from these cows make the best of beef. After milk was withdrawn from the ration, corn gave better results than a ration of gluten meal, bran and linseed meal. After weaning, a ration of alfalfa, corn meal and oats was found very effective. In Illinois corn silage proved better than shock corn in forcing baby beef.

It has been thoroughly demonstrated at the Minnesota, Iowa, Utah, and Canadian Stations that, after weaning, calves may be maintained on a good growth ration of hay, silage and common farm grains, and then forced so as to be in market condition at 1 or 2 years of age. Better prices are thus obtained for farm crops than if sold directly. At the Canadian Stations baby beef was produced most cheaply on corn silage, with ground barley and peas, and linseed meal. Profits in baby beef from skimmilk calves were much greater than when whole milk was fed. When a forcing ration is given during the first year, the animals may not endure feeding the second year. Their health fails and there is financial loss. If forced from early life, calves should be finished off soon after the end of the first year or not later than 18 months. In Kansas skimmilk calves, fed alfalfa and corn for

7 months, proved to be as valuable for the production of baby beef as calves raised with the cows. "The farmer who raises and fattens mature steers has to furnish pasture for his cows, the yearlings, the 2-year-olds, and often for the 3-year-old steers. He waits 3 years from the time the calf is born until he realizes on the investment, and only one-fourth of his herd are cows producing calves. If the farmer will produce baby beef, he can fill his pasture to the full limit with cows producing calves, and he will realize on the calves 12 months from the date of their birth. Capital is turned annually instead of once in every 3 years. The farmer's grain will produce from 50 to 100 per cent more pounds of baby beef than it will of beef from a mature steer, and the baby beef animal has sold for as high prices per hundred as has the average steer.

"In producing baby beef, the farmer can market his heifer calves at the same price as his steers, and will usually get more for the 12-month-old heifer than he would for the same animal if kept until maturity."

In raising calves for dairy or breeding purposes or for the production of mature beef at the age of 3 years or older, the same general plan of feeding should be adopted as outlined above, except that after weaning, the calves should not be forced, but should be fed so as to gain 1 to 1¼ pounds per day after 4 months of age.

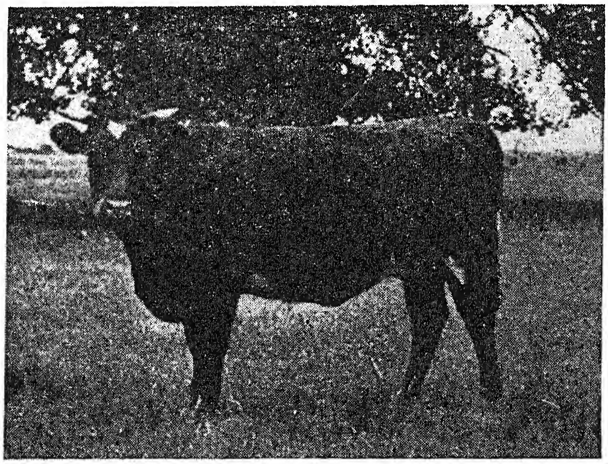
If calves are to be fed for veal they should be forced from the start on milk and grain. In some markets the top prices are obtained only for calves which have been fed exclusively on whole milk. In general calves should be in prime veal form at 6 to 8 weeks of age. In Europe this plan is generally adopted and calves are muzzled to prevent them from eating straw or bedding. They are given a little chalk or ground shells to prevent scouring.

BABY BEEF 4-H CLUB CALF

Fattening Steers. CONDITIONS AFFECTING THE GAINS, STEERS VS. HEIFERS. At the Iowa Station a comparison was made between steers and heifers, spayed and unspayed, with reference to their beef qualities. Spaying temporarily retarded growth. Steers gave the largest profits, unspayed heifers the least. The percentage of dressed weight was about the same in all. The heifers gave more rib and loin cuts than the steers. In later tests spaying was found of little if any benefit and heifers gave more profitable carcasses on the block than steers. The cost of feeding and rate of gain was practically the same for steers and heifers. There is a prejudice in many markets in favor of the steer even when heifer carcasses are of better appearance.

SHELTER. The results of comparison of indoor and outdoor feeding do not show any great uniformity. Range steers, or any steers which are not accustomed to being handled, are more or less worried by confinement and may fail to make satisfactory gains. Such animals do best when given the liberty of yards with accessible shelter. Steers generally eat more in yards than in stalls. In winter more feed may be required for a given gain in outdoor feeding than in warm barns. Many experiments have shown no difference in favor of either indoor or outdoor feeding. Comparisons of feeding in box stalls and stanchions are mostly in favor of box stalls. Only gentle or dehorned animals should be turned together in box stalls. In Nebraska, steers fed in box stalls made better gains than those in open sheds. In Minnesota more economical gains were made in open sheds than in stables. The cost of providing barns and sheds will largely determine the question with different stockmen. As a rule a certain amount of exercise seems necessary to the best results in fattening, especially if the period is long, but shelter should be accessible so that the cattle may not suffer from severe storms.

Experiments in Illinois indicate that, while exercise is expensive from the standpoint of feed cost, the amount of walking required of cattle even on scant pasture does not have a detrimental effect on the quality of the beef. On the contrary, it appears that heavy exercise makes beef more tender.



MILKING TYPE OF SHORTHORN

RANGE CONDITIONS AND RANGE STEERS. It is a matter of common knowledge that the day of the old cattle kings has gone. The Western ranges, however, still produce a large percentage of the cattle which serve as feeders for the big cattle markets. In former years no attempt was made to feed or shelter range cattle in winter. Now the majority of cattle ranchers raise forage for winter feeding. The estimated cost of running cattle on the range is $2 to $4 per head per year. One bull is allowed to every 25 to 50 cows. It is not considered desirable that range heifers should have calves until they are 2 or 3 years old. A certain percentage of cows are barren or abort, but about 80 per cent of range cows should drop calves.

At the Iowa Station it was found that range steers could not be bought and fed with as much profit as may be obtained from a herd bred for the purpose of combining dairying and beef making on the same farm. Range steers vary exceedingly in their fattening qualities and in the profit which they return. If they are wild or of sullen disposition they make poor gains. They cannot be fed an excessively large grain ration and cannot be forced for a long period with profit. At the Minnesota Station it was found that range steers weighing 1200 pounds could be brought to good condition within 130 days on 9 pounds of mixed meal daily (bran, barley, corn and linseed meal) with silage and hay. Beef was thus produced at a cost of 3.8 cents per pound. A num-

ber of large companies have for years been engaged in the business of feeding range cattle. During the 11 years from 1886 to 1897 the Standard Cattle Company fed 49,648 cattle from 4 to 5 years of age. The average length of the feeding period was 186 days, the average weight at the beginning of the feeding 1036 pounds, at the close 1260, the average daily gain 1.2 pounds, the average grain ration 16.7 pounds, and the average hay ration 12 pounds.

A study of the growth of purebred Herefords on Montana range land from calfhood to maturity, showed that little change of weight occurred after the age of 3½ years, and that the maximum production of milk by range cows comes at the age of 6, the ages of 4 to 8 being the best producing years.

Forest lands contribute a large percentage of the year-round feed of cattle on the coastal plain of Georgia, furnishing grazing March 15 to October 15. Forest pasturage must be supplemented by tame pasture of Bermuda, carpet grass and annual lespedeza.

Age and Gains. The amount of feed required for a pound of grain increases with the age of the animals. The cost of gain also increases in the same proportion, while the rate of gain decreases as the animals grow older. In young calves a pound of gain has been produced for each 1½ to 2 pounds of dry matter fed. The required amount gradually increases until adult age, when from 10 to 12 pounds of dry matter are consumed for each pound of gain. The same law holds good for sheep and pigs.

In Alabama 18-year-old oxen were fed at a loss, while young steers made good gains on the same feeding stuffs. At the Maryland Station is was found that dairy cows 6 years old or less could be fattened at a fair profit, while cows 8 to 10 or more years old were fed at a loss. Work oxen 6 years old were fattened at a good profit. In Colorado, Oklahoma, North Carolina and other States, as well as in Canada, more profit was found in 2-year-old than in 3-year-old steers. At the Ottawa Station the cost of 100 pounds of gain was as follows: In calves $4.89, in yearlings $7.23, in 2-year-olds $7.45, and in 3-year-olds $13.75.

The following table prepared from results obtained in American and foreign experiments, indicates the influence of the age of the animal upon the rate of gain:

Age of cattle in yrs.	Av. age yrs.	No. of localities	No. of trials	No. of animals	Av. gain per day in lbs.
⅓ to 1	½	4	19	70	2.30
1 to 2	1¼	12	41	361	2.09
2 to 3	2½	16	50	506	1.58
3 to 4	3½	7	27	208	1.44
4 to 5	4½	2	13	49,654	1.20

The majority of the 4-year-olds in the above table were fed by the Standard Cattle Company. The figures for the other ages are compiled from experiments in such a variety of localities and with such a variety of feeding stuffs that we may safely assume considerable reliability for the accuracy of the average daily gains indicated by the different ages.

Length of Feeding Periods and Gains. In general the longer the fattening period the larger the amount of feed required for a given gain. At the Kansas Station it was found that for a feeding period of 56 days 730 pounds of grain made 100 pounds of gain, while for a period of 182 days 1000 pounds of grain were required for the same gain. In some animals it costs 4 times as much to produce a pound of gain at the end as at the beginning of the feeding period. Forced feeding, especially for long periods, is an unnatural process. There is a limit in all cases to the amount of fat which an animal can be made to lay on. Nature may then protest by failure of appetitie, lessened ability to make good use of food, or in other ways against a continuation of the forcing process. When cattle reach a good market condition they should be promptly sold. The last few pounds of gain are very expensive.

In Texas a desirable market finish was produced in yearling steers by feeding periods of 200 days on rations of 25 to 30 per cent concentrates, and 70 to 75 per cent roughage. This was nearly twice as long as was required for fattening with high grain rations, but permitted the use of large amounts of roughage which re-

duced feed costs. The rate of gain, per cent of shrinkage, dressed yield and carcass grades all favored the high grain rations.

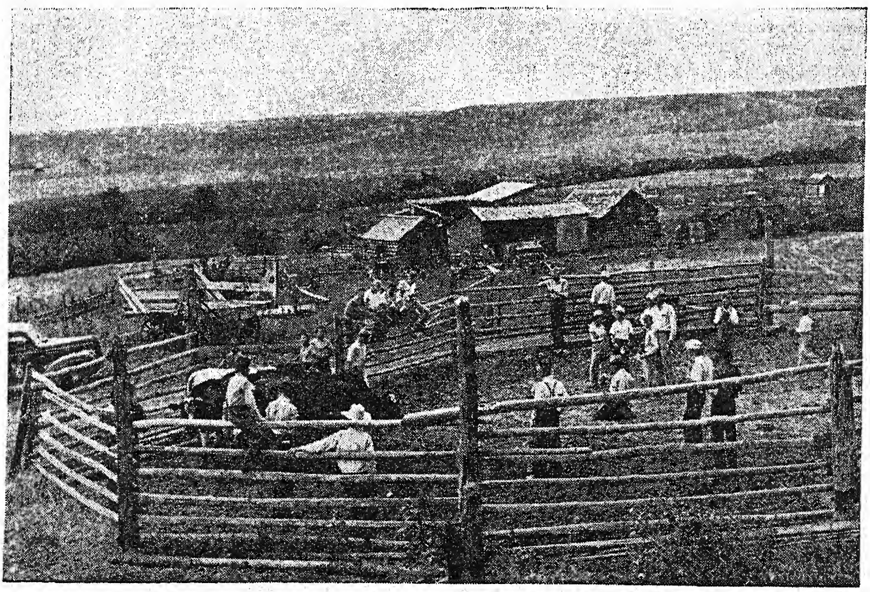
Effect of Dehorning. At the various stations where dehorning has been tested it caused a loss of 7 to 50 pounds in weight per head. Steers required from 5 days to 2 weeks to regain their original weight. The check in growth of steers due to dehorning is therefore not serious enough to outweigh the advantage of greater docility. If range steers or animals with an ugly disposition are to be fed in confinement with safety they must be previously dehorned.

Grains for Steers. Cattle cannot be successfully fattened without the liberal use of grain in the rations. The value of the grains which are commonly fed to cattle may be discussed at this point.

CORN, for the greater portion of the country, unquestionably stands at the head of the list of grains for economy and effectiveness in beef production. It may be fed as the only grain in the ration in feeds of from 4 to 18 pounds a day, but better results are usually obtained when small amounts of cottonseed meal, linseed meal, barley, wheat or peas are fed with the corn.

At the Colorado Station corn and wheat appeared to be about equally effective, but on shipping the shrinkage was much less in the corn-fed steers. The latter were also far ahead of those fed on barley with or without sugar beets. Corn proved slightly superior to Kafir corn in Oklahoma, and about equal in feeding value to wheat meal in Ohio. In Pennsylvania corn showed a higher feeding value than wheat. In Virginia corn, either whole or ground, made greater and cheaper gains than cottonseed products, the cheapest gains being made on whole corn (12 pounds per day), with hay and silage. In Texas corn crops proved more profitable when used during the whole feeding period than when used to finish off steers which had been fed on cottonseed products. Gluten meal was found superior to linseed meal in Ohio. In Illinois gluten meal produced the required market finish in steers most cheaply of several rations tested.

Many experiments have been made to determine the relative value of dry and soaked corn and to compare unhusked ears, corn in the ear, whole shelled corn and corn meal. At the Kansas Station less corn was found in the droppings of steers when the corn was fed soaked than when dry fed. If it costs more than 6 cents per bushel to soak the corn it will not pay. Where the stock grower raises his own corn he cannot afford to expend any labor on it after it is matured. It should be fed in the ear without husking. In that



FOUR-H CLUB JUDGING LIVE STOCK

form it is about as effective as corn meal, and the cost of husking, handling and grinding is saved. If hogs are allowed to follow steers in the feed lot all the undigested corn is utilized by the hogs. (*See* under *Swine*.) In Iowa the use of whole corn resulted in cheaper gains than corn and cob meal. In one test at the Kansas Station whole corn proved equal to corn meal, in another slightly inferior. About 15 per cent of the whole corn was passed in the manure and 6½ per cent of the corn meal. All of the former and practically none of the latter can be utilized by pigs. At the Minnesota Station it was found that steers would eat much more corn meal than they could digest, and it was thus wasted. Corn meal fed to steers at pasture did not give profitable returns. The meal was apparently carried out of the alimentary tract by the green feed before it was digested. The economy of feeding corn whole is also shown by experiments in Wisconsin. At the Texas Station a considerable saving was made by feeding corn, cob and husk coarsely ground together.

Barley, especially the bald variety, may be fed as the only grain or in combination with other grains. At the Montana Station barley gave profitable returns when fed to steers with alfalfa or clover. It was found that ¾ pound barley per day for each 100 pounds live weight of the steers was sufficient to produce good gains. In North Dakota barley gave greater and faster, but more expensive gains than bran and shorts. In Utah barley was found to be cheaper and more effective than pea meal for steers. Barley produced nearly as rapid gains as corn in Colorado, but shrinkage in shipping was greater. In Scotland barley bran produced more profitable gains than linseed or cottonseed meal. In Germany excessive feeding of the distillery refuse of barley and other grains had an unfavorable effect on the quality of beef. At the Woburn Experiment Farms it was found that dried brewers' grains could not be profitably used to replace all the hay in a ration for steers. When replacing part of the hay they made rapid gains.

Beans have been but slightly tested in feeding experiments with steers, although they are fed to a considerable extent. "Jack bean" meal was not relished by steers in Mississippi and proved to be very indigestible. At the Kansas Station soy bean meal proved equal to cottonseed meal in feeding value and much superior to linseed meal. This meal may well be fed with a larger quantity of corn or Kafir corn. At Woburn horse bean meal produced rapid gains in steers.

Cottonseed constitutes the most important ration for steers in the Southern States. Pound for pound it is superior to all other grain feeds in effectiveness in beef production. It may be fed raw, boiled, roasted or ground. It may be the only concentrated food in a ration or may be fed in conjunction with corn, Kafir corn or other less highly nitrogenous grains. Neither cottonseed nor cottonseed meal is a safe feed if allowed to become rancid or dark colored. The meal should be perfectly fresh and of a yellow color. Cottonseed may be used as a complete ration for steers, the meal constituting the concentrated feed and the hulls serving as coarse fodder. There is also a "cottonseed feeder" on the market supposed to contain 4 parts hulls and 1 part meal.

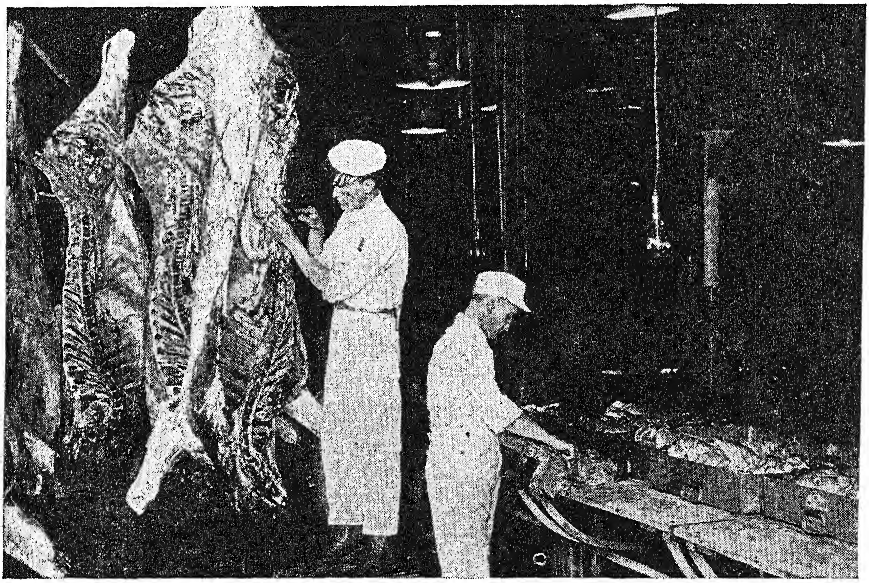
At the North Carolina Station good gains were made on an exclusive diet of cottonseed meal and hulls for a period of 81 days. The meal and hulls were fed in the proportion of 1 to 4. They may be fed for different purposes in proportions ranging from 1 to 1½ to 1 to 7. The ratio 1 to 1½ is well suited to rapid fattening. The hulls alone are not sufficient for maintenance, except perhaps those from green seed.

At the Texas Station cottonseed meal and hulls proved equal or superior to any other ration. Roasted or boiled cottonseed was found more palatable and less laxative than raw seed, but the cheapest gains were made on the raw seed. The best ration of meal and hulls for cheapness was 1 to 5 or 6, for rapid gains 1 to 3. Cottonseed did not produce any striking effect on the quality of the beef, but made a harder tallow than corn.

At the Arkansas Station cottonseed proved to be the cheapest and best grain for cattle. The whole seed was equal to the meal and hulls for a period of 60 days, but the extra quantity of oil in the whole seed caused loss of appetitie in longer periods of feeding. The hulls should be fresh and free from seed, otherwise they may cause scouring. Hay may be fed if the animals scour. A ration containing 8 pounds cottonseed meal and 25 pounds hulls gives results equal to corn feeding.

In Mississippi 1 pound cottonseed meal proved equal to 1.66 pounds cottonseed or 1.9 pounds corn, and 1 pound of gain was produced by 2.4 pounds cottonseed meal. Cottonseed meal was fed in ra-

tions of 5½ pounds per day without harm, but 7½ pounds was too heavy a ration. The Oklahoma Station found cottonseed less satisfactory when fed alone than when combined with other grains. It rarely affects the health of steers except when fed to excess for long periods of hot weather. Eight pounds is considered a maximum feed and 4 to 6 pounds gave better results. Cattle may then lose appetite, but are not seriously affected. In the Northern States cottonseed is very effective when fed with some other grain, say corn, in the ratio of 1 to 4. In Tennessee cottonseed meal gave best results when mixed with corn meal in ration of 1 to 1¼.



GOVERNMENT MEAT INSPECTION

KAFIR CORN, although slightly inferior in feeding value to corn, may be substituted for the latter in a ration for steers. At the Kansas Station its feeding value proved to be somewhat lower than that of corn, and its fat was less digestible. Both red and white Kafir corn were found to be almost equal to corn in long fattening periods for steers. Corn meal was better digested than Kafir corn meal, 5½ per cent of the corn meal, 12 per cent of the red and 14 per cent of the white Kafir corn meal being found in the manure. Red kafir corn proved somewhat superior to the white variety.

At the Oklahoma Station 10 per cent more Kafir corn meal than corn meal was required for a given gain. Kafir corn was found to be more digestible when soaked, and enough more effective when ground to pay for grinding.

LINSEED MEAL is fed to steers and other farm animals for its beneficial action on the general health, as well as for its nutritive qualities. It should be fed in small quantities as a part of the grain ration. In Iowa it was found quite inferior to corn meal for steers at pasture, and proved inferior to gluten meal in Ohio. At the Kansas Station an exclusive diet of linseed oil cake did not produce as good results as corn meal or a balanced ration. In Canada linseed meal added to a ration of grain and silage gave excellent results. Linseed cake was found a more profitable feed in England than cottonseed meal or dried brewers' grains. In Scotland it gave greater but more costly gains than cottonseed meal and oats.

OATS have not given very favorable results in fattening experiments with steers. Practical feeders, however, secure good profits from them when fed with other grains. In recent years oats have been fed to steers less extensively than barley and wheat. In Texas oats proved equal to corn chops for fattening steers, while in Wyoming chopped oats were fed at a

loss, and in Canada oats in the sheaf had a smaller feeding value than wild rye grass. An experiment with oatmeal in Canada showed it to be far inferior to wheat.

PEANUTMEAL. In Florida yearling steers made good gains on rations containing 2 pounds peanutmeal, 12 pounds shelled corn, 3 pounds legume hay, and corn or sorghum silage.

PEAS, whole or ground are extensively fed in Canada and the Northern States. In one test at Toronto pea meal was found slightly inferior to corn meal, while in a later trial it gave greater but more costly gains. Peas and oats as a grain ration proved far inferior to wheat or oatmeal. Pea meal constitutes a portion of the mixed meal which is almost universally used in feeding steers in Canada. The large cattle feeding companies report good results from peas in fattening steers.

in Oregon, but the gains were costly and the meat did not mature so well as in steers which were fed ground wheat. In Wyoming cracked wheat was fed to steers at a loss. Frozen wheat has as high a feeding value as uninjured wheat and may be fed to steers with good profit. In Canada the use of frozen wheat and silage resulted in good gains and an excellent quality of beef. In England it was found that wheat could profitably be used to replace linseed meal in fattening steers. Chopped wheat with corn silage and hay gave good results in Idaho. In Nebraska wheat showed a feeding value 5 per cent greater than corn. Hogs following steers fed on wheat made profitable gains.

At the Toronto Station the following results were obtained in a comparison of corn, peas and oats for steers. Besides grain the steers received roots, silage and hay:

Grains	Daily gain per head	Cost per lb. of gain	Cost per steer Oct. 1 to June 1
Corn	1.91 lbs.	4.8 cts.	$20.75
Peas	1.83 "	5.2 "	22.50
Oats	1.60 "	5.8 "	25.10

WHEAT should not constitute the whole or even a large part of the grain ration for steers, except when the market price is low. In Minnesota it was found that wheat could be fed with profit and advantage to fattening steers when the market price was not higher than 47½ cents per bushel. In Colorado wheat, with or without sugar beets produced good gains in steers. The shrinkage on shipping was greater than with corn, but less than with barley. Ground wheat proved superior to ground barley. At Toronto wheat bran was found more valuable for feeding purposes than whole wheat or wheat flour, and the new process bran gave the best results. In Maryland the new and old process wheat bran proved to be of equal value. In Oregon and Pennsylvania wheat alone was less effective than when mixed with corn or some other grain. Steers did better than pigs on wheat in the sheaf

The best grain feeds for beef production in the corn belt are corn, Kafir corn and linseed meal; in the Northern and Western States corn, peas, barley, wheat and linseed meal; and in the South cottonseed, corn, Kafir corn, and soy bean.

The average amount in pounds of different grains required for 100 pounds of gain in steers is shown in the following table, which is prepared from more than 100 experiments involving over 750 animals:

Barley	Corn	Kafir corn	Oats	Peas	Wheat	Mixed grain
914	1,028	1,058	1,032	911	1,090	871

In the majority of feeding experiments a mixture of grains has been found more effective than any one of the grains in the mixture, and this fact also appears in the table of averages just given.

Coarse Fodder for Steers. A portion of the ration for steers must always consist of forage plants or roots. This part of the ration may be given as pasture, by soiling or by feeding hay, silage or roots

in stalls or yards. The results obtained from experiments in pasturing steers are not very uniform. In Iowa steers often lost weight when turned on pasture, even when grain was fed. The loss was apparently due to exposure to heat and annoyances from flies. In Oklahoma steers on bluegrass pasture made very small and unsatisfactory gains for a period of 105 days. At the Ohio Station, when nearly finished, steers were turned on pasture without change in their grain ration, they were checked in their growth or actually lost in weight. The same experience was had in Canada. In Minnesota sorghum, oat or rape pasture supported steers longer than field peas or corn, which latter do not sprout again after being eaten off. In Montana, alsike clover made excellent pasture.

The results obtained at several experiment stations indicate that it does not pay to feed grain to steers at pasture. This practice, however, is followed by many practical feeders with excellent results. Much depends upon time of year and condition of the pasture. Steers ordinarily gain rapidly on good pasture. Under no circumstances should a sudden change be made after the steers are finished, from stalls to pasture or vice versa. A check or loss in weight is almost sure to follow. In Nebraska, grain feeding was profitable when steers were marketed in the fall but not when they were held till spring. Cattle fattened exclusively on pasture in Illinois graded only medium because of yellow fat and lack of finish. But cattle fed a full grain ration on pasture produced a meat as palatable as that from steers fattened in dry lot. Yellow fat was not objectionable to all consumers. Experiments in Virginia showed rapid pasture improvement when properly fertilized. Phosphorus was most needed, but nitrogen stimulated the grasses, and potash helped the legumes. Without adequate phosphorus in the ration, the Idaho Station found that steers made poor gains and were unthrifty. Free access to a mixture of 2 parts bonemeal and 1 part salt remedied this deficiency. Texas steers made a greater and cheaper gain when they were finished in the dry lot after pasturing on sudan grass during spring and summer.

Soiling is a practice which is most largely followed by dairymen. It has not been tested to any great extent in fattening steers. In Massachusetts steers made much more rapid gains on soiling than on pasture. By the former method they ate more feed and the profits were about the same. Soiling with rye, clover and corn was found equal to pasture in Pennsylvania. In Utah pasturing, soiling and feeding hay seemed to be equally effective.

Roots are perhaps most valuable during the first part of the fattening period. From 40 to 50 pounds per day may be fed at first and the amount should be gradually diminished. In England it was found that more than 30 pounds of roots per day was apt to cause scouring. In Utah roots showed no advantage over ordinary air dried fodder. Steers fed on roots had larger vital organs, less fat and a smaller percentage of dressed weight than those which received dry fodder. Roots were, therefore, considered unprofitable as feed for steers. Silage is a more economical feed for steers than roots. Results secured in feeding experiments with the various kinds of roots are noted beyond under *Roots for Steers*.

The use and value of coarse fodders most commonly fed to steers may be briefly discussed at this point, alphabetically.

Alfalfa Hay, throughout the regions where it is extensively grown, is one of the most important hays for cattle. At the Colorado Station 1 pound of alfalfa hay was found equal to 2.69 pounds corn silage. It proved equal to corn fodder pound for pound. The addition of grain to an alfalfa ration greatly increased the gains, but did not lessen the amount of hay eaten. In feeding steers a greater profit was derived from alfalfa than from corn fodder or silage. In Arizona 18 pounds of alfalfa hay and 2.6 pounds of wheat were required for 1 pound of gain. It proved better than sorghum, but when fed with corn fodder, Kafir corn fodder or sorghum greater gains were made than when alfalfa was fed alone. In Utah alfalfa silage was inferior to corn silage, but the hay was superior to timothy or wild hay. In Nevada from 15 to 21½ pounds of alfalfa hay were required for 1 pound of gain in 2-year-old steers. With full feeds of alfalfa only a small amount of grain is required to make rapid gains.

At the Utah Station it was found that alfalfa cut just before blooming made better gains in steers than when cut in full bloom or 1 week after full bloom. The early cut of both the first and second crop proved to be superior. To secure the best feeding value it should therefore be cut between medium bloom and first full flower. The digestibility remains the same from the period of bud to that of

full flower. Pound for pound the third crop was found to have the highest feeding value, followed by the first and second crops. The leaves proved to be 2 or 3 times as nutritious as the stems.

Buffalo-Grass Hay may well be fed to fattening steers wherever it is grown to such an extent as to make its harvesting economical. In Kansas it was found to be better than prairie hay and far superior to timothy.

Chess is often fed to steers, but there is very little experimental evidence concerning its value. In Oregon it proved slightly inferior to clover hay, but was valuable in a maintenance ration wintering cattle.

Dried Citrus Pulp from the canneries in southern Texas proved to have considerable feeding value.

Clover in the Central and Eastern States occupies the position in rations for steers which is filled by alfalfa in the West. In Tennessee the first crop had a greater feeding value and was better relished than the second crop, which caused salivation. In Mississippi greater and cheaper gains were made on clover hay than on shredded corn stalks, cowpea hay or crabgrass. In Indiana steers made better gains on chopped than on whole clover hay.

Corn throughout a large portion of the country furnishes the chief coarse fodder for steers. It may be fed in the form of corn stover, corn fodder, pulled fodder, shredded corn stalks, corn shives or the "new corn product," silage or as a soiling crop. As a rule corn can be most economically harvested and fed in the form of silage.

In Colorado 1 pound corn fodder was found equal to 2.4 pounds corn silage. In Iowa corn fodder proved superior to timothy hay, corn silage or sorghum silage. At the Illinois Station the digestibility of corn fodder and corn silage for steers was found to be the same. The fodder gave slightly larger gains in yearling heifers than silage. The heifers which were fed silage ate more and required more feed for a given gain. In Arizona the fodder was equal to alfalfa. Silage was superior to carrots and mangel-wurzels in Idaho. At the Maryland Station corn fodder gave best results when shredded moistened and mixed with the grain ration. It was then more digestible, better relished and eaten more completely. The fodder showed twice the feeding value of cottonseed hulls. The corn shives or "new corn product" proved superior to shredded corn fodder, corn blades or timothy hay. It keeps well, is greatly relished and is convenient to feed. Cattle chew the cud after feeding on it as if fed on corn fodder or hay.

In Mississippi shredded corn stalks were found to require silage mixed with them to make them palatable. They were inferior to cowpea hay, crabgrass or clover hay, but their cheapness more than counterbalanced their inferior feeding value. Air dried corn fodder was more economically stored and handled than silage and was nearly equal to silage in feeding value.

In Massachusetts silage with gluten meal gave the best and cheapest gains of the several rations which were tried. In North Carolina silage with cotton seed meal gave rapid gains. Corn silage fed in rations of 44 pounds for 11 days, followed by soy bean silage in rations of 44.8 pounds for 46 days produced moderate gains without grain. Silage was found more palatable than fodder at the Ohio Station. In Texas silage proved superior to dry fodder in feeding value. In Utah the fodder was found to be more effective than silage. In Virginia much cheaper gains were obtained from silage than from hay. In Wisconsin silage with a heavy grain ration was exceedingly effective, 35½ pounds of silage making 1 pound of gain. The silage from 1 acre made 700 pounds of beef.

Cowpea Hay has been found an exceedingly valuable fodder for steers in the Southern States. In Arkansas it is considered the cheapest and best hay for cattle. Cowpea hay was found more digestible than clover hay in Illinois. In Tennessee 2 to 3 pounds of cowpea hay proved equal to 1 pound of cottonseed meal. Together with grain it may be fed in rations of 20 pounds per day. In Tennessee the hay made a good substitute for cottonseed meal when fed at the rate of 2 or 3 pounds for each pound of the latter.

Kafir Corn stover in Oklahoma proved somewhat inferior to alfalfa hay but equal to corn stover. Kafir corn fodder was found to be inferior to corn fodder. In Kansas Kafir corn stover proved superior to corn stover.

Rye Grass is cut for hay in various parts of the country. In Canada it was found superior to oats in the sheaf for fattening steers.

Silage is here used to include certain kinds of mixed silage. In Maryland a silage containing corn, sorghum and soy bean when fed alone in ration of 40 pounds

proved more than a maintenance ration for heifers in winter. In Canada the cost of gain on corn silage was 27 per cent greater than on Robertson's mixture. *See* under *Sunflower*.

Sorghum proved equal to alfalfa for steers in Arizona. In Iowa sorghum silage was as effective as corn silage, but was not so well relished. Hegari silage proved nearly equal to alfalfa hay in recent tests in Arizona. In New Mexico all of the non-saccharine sorghums were readily eaten by cattle and were usually preferred to alfalfa hay. Sorghum as a soiling crop produced rapid gains in Tennessee. In Texas it was found that steers shrunk less on shipping when fed on sorghum and cottonseed meal than when fed on meal and hulls alone.

Sugar Cane. In Florida it was found that sugar cane harvested from November 1 to 10 can be kept in good condition for feeding for 4½ months by shocking in round shocks of approximately 1 ton green weight. Sugar cane stacked with butts on the ground to a depth of 20 feet against upright supports is a practical method of storage. If the cane is to be used within a few weeks after harvesting it can be stacked to a greater depth than 20 feet. This method is to be recommended when large quantities are to be stored.

Mature beef cows fed shocked sugar cane as the only source of roughage in three wintering trials remained in a thriftier condition than did those fed sugar cane silage or grazing carpet grass.

Soy Bean furnishes an excellent coarse fodder for steers. It is mostly fed in the form of silage. In Illinois the silage proved as digestible as clover hay.

Straw of various sorts may profitably be fed with leguminous forage plants, other hay and grain. Steers usually eat straw more freely if given the liberty of a yard. Oats furnish the best straw. In Canada cheaper gains were made on a ration containing wheat straw than where hay was used. Oat straw mixed with silage in the proportion of 1 to 3 makes a good roughage for steers.

Timothy at the Iowa Station proved inferior to corn fodder, but better than sorghum silage. For the maintenance of young steers about 19 pounds daily are required for each 1,000 pounds of live weight. There is no difference in the feeding value of early and late cut timothy hay. The dry matter in timothy hay and corn silage was found to be of equal value at the Maine Station. In Utah timothy proved equally digestible green and as hay. It was found inferior to "wild hay." In Illinois, timothy proved inferior to clover and tended to the production of intestinal fat.

Vetch Hay, from experiments made at the Oregon Station, would appear to be about equal to clover hay for steers.

Roots for Steers. In feeding steers all roots should be sliced or pulped. They may be profitably fed to steers wherever they may be produced cheaply. Brief notes on a few roots follow:

Carrots produced smaller gains in steers than dry fodders in Utah.

Cassava has been fed to steers in experiments at the Florida Station. It is a starchy feed and should be fed in combination with cottonseed meal, cowpeas or velvet beans. The profit from feeding cassava was greater than from corn, but less than from cottonseed.

Potatoes are often fed to steers when the potato market is low, but very few experiments have been made to test their value. In Germany it was found that they could be fed to steers in rations of 60 pounds per day in combination with clover hay and linseed meal.

Sugar Beets were found to have a feeding value of $3 per ton in Colorado. In Wyoming when used in rations of 14 pounds per day with alfalfa hay they made profitable gains. Beet leaf silage did not show much feeding value in German experiments.

The residues from the manufacture of beet sugar are fed in enormous quantities to stock in Europe and in this country. In France beet pulp has been fed to steers in rations of 115 to 126 pounds daily together with alfalfa and linseed meal. The steers made good gains. The beet sugar factories throughout the country are selling pulp to the farmers, or giving it to them for hauling away. Reports thus far received are favorable to its use.

Miscellaneous Feeds for Steers:

Condimental and Medicinal Feeds, according to careful investigations at the Connecticut, Massachusetts and New Hampshire Stations, are compounded of well-known feeding stuffs and common drugs and sold at a ridiculously high price as compared with their value. The price charged for these patented feeds is from 3 to 10 times their real value and the extravagant claims made for them are quite unfounded.

Molasses of different origin has been fed much more extensively in Europe than in this country. In Texas it did not improve a ration containing silage. In Kan-

sas it was found to be of little value for fattening steers. In France it was found valuable for making inferior hay more palatable. The use of molasses, however, is increasing rapidly.

WATER. At the Pennsylvania Station it was found that animals which had a supply of water before them all the time had a better appetite and consumed their feed with more relish than steers which were watered but once a day. A self-watering device saved some work and appeared to effect economy in amount of grain for 1 pound of gain. In North Carolina 2½ pounds of water were drunk by steers for each pound of dry feed (cottonseed meal and hulls). It does not pay to warm the water for steers except in the very coldest weather. In moderate weather warming the water proved harmful at the Minnesota Station.

SALT. A supply of salt should always be accessible to steers, preferably in the form of large pieces of rock salt. It has been estimated that steers require about 1 ounce per day for each 1000 pounds of live weight. Range steers are sometimes salted at regular intervals and sometimes left to satisfy their appetites in this direction by eating alkali. The latter practice cannot be recommended except where the alkali contains a large percentage of salt.

Loss of Appetite is usually due to feeding too large rations, to feeding moldy, fermented or unclean grain or fodder, to feeding one ration too long without change or to feeding a too one-sided ration. Getting off feed is a serious matter in fattening steers, and one concerning which no detailed advice can be given. Each stock raiser must learn by experience how to recognize the cause of the trouble and how to remedy or prevent it.

Number of Meals per Day. No valuable evidence has been obtained from experiments to determine whether it is best to feed steers 2 or 3 times per day. It may be well to feed young calves 4 or 5 times a day. Yearlings probably do better on 3 than on 2 meals per day, while 2 meals are enough for older cattle. At the Utah Station steers made greater and cheaper gains on 2 than on 3 meals per day. In fact good results are obtained when the grain ration is given at a single feed each day.

Rations for Steers. In the hands of different feeders satisfactory results may be obtained from rations differing greatly in nature and composition. All forcing rations must contain both grain and coarse fodder. The relative proportion of grain and coarse fodder, however, will vary according to the nature of each and according to other circumstances. A few suggestions from experiments in various States are presented in this connection.

In Kansas steers allowed to graze on cowpeas and standing corn fodder and receiving cottonseed, made gains at a cost of 1.6 cents per pound. In Iowa a varied ration made cheaper gains than a single one. In finishing steers better results were obtained from narrowing the ration in the last period than from widening it. Changing steers from dry feeds to pasture or vice versa caused a period of slow and expensive gains. The cost of grain on dry feed was greater than on pasture, being 1.65 cents on grass alone and 4 cents on grain and pasture.

In Iowa narrow rations gave greatest, and wide rations cheapest gains. The same results were obtained in Kansas where in repeated tests corn meal gave more profitable returns than balanced rations. In Maryland greater gains, a higher price for the meat and more profit were obtained from a narrow ration. Wide rations gave greater gains than narrow ones in Maine. (For a discussion of "wide" and "narrow" rations, "balanced" rations, etc., *see* under *Feeding Farm Animals.*) This result is in agreement with those from experiments in New York and Tennessee, as well as in Germany and Scotland. At the Maine Station it was found that up to 15 months of age greater gains were obtained in cattle from a nitrogenous ration, while in older steers the wide ration gave the best result. The relative weight of the internal organs and parts of the body and the proportion of fat, lean and water was the same from both rations. In Michigan a better quality of meat was obtained from a nitrogenous ration than from corn meal alone, while exactly the opposite result was obtained in New York.

At Toronto light grain rations were found more economical than heavy ones, but more rapid gains were made on the latter. The most economical method for long periods was found to be ⅓ pound of grain for each 100 pounds of live weight at the start, this amount to be gradually increased so that the average for the whole period would be ½ pound per day for each 100 pounds of live weight. Similar results were obtained in Montana. At Ottawa it was found profitable to omit grain entirely, or nearly so, from the first part of the feeding period.

In Utah with steers which were fed 4, 6 and 8 pounds of grain per day the rapidity of gain increased and the cost decreased with the increase in the amount of grain. At the Ohio Station a heavy grain ration proved more profitable than a light one. In Minnesota steers which received 25 pounds of silage and hay per day made cheapest gains when fed 8½ pounds of mixed meal daily. When fed more than 10½ pounds per day they failed to make correspondingly increased gains. In other words, they were eating more than they could digest. In Massachusetts it was found that the larger the amount of hay fed the greater the cost of gain.

In Minnesota steers weighing 1050 pounds ate 25 pounds of silage, 8⅓ pounds of hay and 8.6 pounds of corn meal daily. Hundreds of rations have been published which are suitable for fattening steers, but detailed directions cannot be given in this matter. Each feeder will compound his rations from the feeding stuffs which he has or can get most conveniently, and according to prevailing market prices. It is believed, however, that some valuable suggestions may be obtained from data presented in the preceding paragraphs.

At the Utah and Illinois Stations the effect of leaving all coarse fodder out of the rations was tested. In Utah cattle which were fed for a long period on grain alone made gains on less grain than that required for pigs for the same gain, and drank comparatively little water. The vital organs were small. In Illinois calves prevented from getting coarse fodder up to 5 and 7 months of age became nervous and showed depraved appetites. These experiments, however, are of little practical value, since the farmer will not attempt anything of the sort.

Dressed Weights, etc. While the percentage of dressed weight has been found to vary from 40 per cent to 70 per cent in extreme cases, the average for various pure breeds, grades and scrubs in experiments conducted at the various stations is about 63.5 per cent. The amount of loose tallow varies from 11 per cent to 33 per cent of the dressed weight, depending largely on the type of animal. The average shrinkage in weight from shipping steers on the railroad as computed from 50,000 animals is 43 pounds per head.

What the Experiments Show:

1. For the production of beef pure beef breeds or good grades should be selected.
2. It does not pay to let calves suck the cows or to feed them whole milk. Feed skimmilk with a little corn meal or linseed meal.
3. It pays to force early maturing breeds from the start and market them at the age of 12 to 16 months.
4. The younger the steers the less feed they require for a given gain and the more rapid gains they make.
5. Steers should be sold as soon as they are finished off. The last few pounds of gain are costly.
6. For steers over 2 years of age a moderately wide ration is more profitable than a narrow one. In other words, corn may constitute the chief grain for fattening.

Dehorning Cattle. The practice of dehorning cattle is generally recommended by the experiment stations. If properly done the operation is not cruel or very painful. Dehorned animals recover from the bad effects of the operation within a few days, and the danger of animals injuring one another, especially in transportation, or in the case of vicious animals, is greatly lessened.

Experiments have been tried of dehorning calves at an early age by means of various chemical preparations. Caustic potash, hydrochloric acid, sulphuric acid mixed with sulphur, sulphuric acid mixed with glue and carbolic acid, chlorid of zinc, chromic acid ointment and chromic acid solution have been used for the purpose. The best success attended the use of caustic potash. This substance should be applied as follows: After clipping the hair from the skin and moistening the developing horn with water to which soap or ammonia has been added petrolatum is applied to keep the caustic from coming in contact with the skin, and a stick of caustic potash is dipped in water until somewhat softened and then rubbed on the moistened surface of the horn. The operation should be repeated from 5 to 8 times until the horn become somewhat sensitive. The whole operation should require only a few minutes. A scab forms over the budding horn and drops off within a month or 6 weeks, leaving a smooth poll. The best results in the use of caustic potash are obtained when this substance is applied as soon as it is possible to locate the horn button on the calf's head, which can usually be done within 3 or 4 days after birth. Caustic potash is the chief constituent of patented chemical dehorning substances and is cheaper than the latter.

The operation of dehorning adult cattle should be performed in mild weather,

neither during extreme cold nor during fly time. A number of dehorning clippers have been patented and are for sale. Adult animals should be dehorned by an instrument which removes the horn at a single stroke. The dehorning of adult animals produces a marked gentleness and docility in animals which were previously vicious.

Diseases:

Tuberculosis, also called phthisis and consumption, is an infectious disease that affects man, all domestic animals and many wild species, occurring most commonly in cattle and swine, and quite rarely in sheep and goats. The sputum, milk and feces of tuberculous animals usually, but not always, carry the infection. External symptoms may be conspicuous or entirely wanting. A rundown condition and a dry, staring coat should awaken suspicions, but are not conclusive evidence of tuberculosis. The lymphatic glands of the throat, point of the shoulder and udder may become enlarged and hard. Such symptoms are more convincing, but no rapid or reliable diagnosis is possible except by the use of the tuberculin test. The milk of tuberculous cows may or may not carry tubercle bacilli.

The tuberculin test was devised by Robert Kock some 50 years ago. Tuberculin contains no tubercle bacilli but it is a product of their growth and causes no harm to healthy cattle, even if much larger than standard doses are used. It may be applied in at least 3 ways. The preferred method is by intradermic injections, or between the layers of the skin. By this test tuberculous animals react within 3 to 5 days by a swelling at the point of injection. When tuberculin is injected under the skin, it causes a fever in tuberculous animals within 8 to 20 hours. If this method is adopted the temperature should be taken at least 3 times at 2-hour intervals before injection and every 2 hours afterward till a positive or negative reaction is shown. A third method consists in placing tuberculin in one eye. Tuberculous animals show a swelling or inflamation of the eyelid within 3 to 10 hours.

Postmortem examinations of advanced cases may disclose tuberculous lesions in almost any part of the body, particularly in the lungs, lymphatic glands, liver, spleen and on the walls of the thoracic and abdominal cavities.

In 1910 the U.S. Bureau of Animal Industry began a campaign of eradication of tuberculosis by means of the tuberculin test and the slaughtering of reacting animals. An honor-roll plan was adopted by which a herd found to be free from tuberculosis on 2 successive annual tests is given an accredited standing, while counties in which only one-half of one per cent of the cattle were found tuberculous were listed as modified accredited. Over 3000 counties have acquired that standing since 1923. Tuberculosis has already been reduced 50 per cent among cattle, and the total eradication of the disease seems to be in the realm of possibility. Since the disease may easily be transmitted to children and adult human beings in the milk of affected cows, and is readily spread from one cow to another in the herd, Dr. A. E. Wight contends that, "The tuberculous cow is the greatest source of danger to healthy cattle, inasmuch as it cannot be determined just when that animal becomes a 'spreader' of the germs unless daily microscopic tests are made of the milk and of the discharges from the body, it is unsafe to keep her with healthy cattle. No cattle from outside sources should be introduced into a healthy herd until they have been tuberculin-tested and found free from the disease. Unquestionably more healthy animals acquire tuberculosis by coming in contact with affected animals than in any other way. It has been observed frequently that cattle which stand on either side of or face tuberculous animals in barns are the first to contract the disease.

"The common water trough, especially in barns, is also the cause, to a very large extent, of spreading the disease. Cattle may become infected by picking over manure infected with the germs of tuberculosis. Hay, straw, or any other feed contaminated with the germs may give the disease to animals that consume such material.

"Water holes and creeks into which the infected milk or the washings from infected milk cans have been dumped may also be a source of the infection. The teat siphon or milking tube, in a number of instances, has been the medium by which the disease has been conveyed from one animal to another. Calves contract tuberculosis by nursing, even for a short time, cows whose udders are affected. Calves also become infected by drinking raw milk from diseased cattle isolated from the main herd. To be safe for feed, milk from such cows should first be heated to a temperature of 145° F. and held there for at least 30 minutes."

In the course of the campaign of eradi-

cation from 11 to 25 million cattle have been tested with tuberculin annually with the result that reactors now constitute such a small percentage of the cattle tested that any other system of control is hardly to be recommended. Even the so-called Bang system whereby reacting cattle are not slaughtered but are segregated and kept out of contact with the rest of the herd, can hardly be approved except in the case of exceptionally valuable purebred animals which may safely be used for breeding purposes, at least during the early stages of the disease. If the animals are of the common stock the cheapest and quickest way out of trouble is to destroy the reactors at once. Likewise the plan suggested by early investigators for immunizing cattle by vaccination with the attenuated virus of human tubercle bacilli fades into insignificance by reason of the difficulty of its application and the uncertainty of its results.

ANTHRAX. This is a virulent infectious disease due to the anthrax bacillus, and is frequently known by the name charbon and carbuncular disease. It is most common in cattle and sheep, but occurs also in horses, mules, goats, dogs and cats. The disease may be transmitted from animal to man. The symptoms of anthrax vary according as the disease begins in the skin, lungs or intestines. Anthrax sometimes occurs in the apoplectic form, in which the animal suddenly falls down and dies in convulsions. In the acute form the disease begins with a high fever and terminates usually with fatal results within 2 or 3 days, while in the lingering form the course of the disease may extend 3 to 7 days and end fatally, or, in some cases with recovery. Breathing is labored and the mucous lining of the nose and mouth shows a blue color. In the intestinal form the discharges may be covered with mucus and blood. Swellings appear as carbuncles, and when opened are found to contain a yellowish mass stained with blood. They appear in the skin, mouth, tongue or rectum. The bodies of animals which have died of anthrax bloat rapidly.

The disease is most prevalent in areas subject to inundation. Pools of stagnant water, and streams polluted with waste material from tanneries, may be sources of infection. Contagion may also be spread through the bodies of dead animals, or by insects or carrion birds, which visit anthrax carcasses. The anthrax bacillus may gain entrance to the body through infected water or food or through wounds in the skin. In Delaware it has been found that there are 5 distinct centers of contagion included in a territory which is crossed by the tidal streams or creeks and subject to tidal overflow. Outbreaks of anthrax in this region were traced to infection from skins used in morocco factories.

Medical treatment as a rule is useless, except in cases which originate from external wounds. The main reliance in combating the disease is to be placed in preventive inoculation. Stables should be disinfected with chlorid of lime or other substance, and cattle should be removed from the fields which are likely to be infected. All infectious material should be burned. Animals dead of anthrax should be carefully buried or preferably burned. The continued prevalence of the disease in some localities has been shown to depend directly upon the neglect to destroy carcasses of dead animals. Vaccination of susceptible animals for the purpose of preventing infection by anthrax has proved very successful, the vast majority of vaccinated animals failing to develop the disease after being exposed. The vaccine material used may be obtained from dealers in such substances.

ABORTION. By this term is meant the premature expulsion of the offspring. Abortion may be noncontagious or contagious. The predisposing causes of noncontagious abortion are generally debility, fevers, acute diseases—especially of the ovaries and bladder—indigestion, bloating, ergot, smutted grains and grasses, or muscular strain.

BRUCELLOSIS, also called infectious abortion or Bang's disease, or undulant fever in man, occurs most frequently in cows but is common in horses, sheep, goats and man. Swine, cats, dogs and fowls are relatively resistant. The disease spreads from animal to animal or herd to herd by contagion. Clean herds may be infected by the introduction of diseased animals. The one positive symptom of brucellosis is the act of abortion. It is estimated that 85 per cent of cases of abortion in cattle are from this cause and that 10 per cent of all cows are infected. Infection takes place most readily through the placenta or its cotyledons in pregnant cows. Calves and unbred heifers show a marked resistance to the disease. The Texas Experiment Station urges that no feed, utensils or appliances be carried from infected premises and that no visitors be allowed to enter clean premises. In Minnesota it is recommended that ad-

ditions to a clean herd should be made only from a herd known to be free from abortion, and even then only after a 60 day quarantine period.

In the absence of external symptoms a blood test for agglutination will quickly detect the presence of the infection. This furnishes the simplest means of detecting the disease. All reactors should be removed and slaughtered. Vaccination has proved reliable in some cases and in others positively harmful. Milk, if pasteurized properly at 145° for 30 minutes, is safe to drink but otherwise it is dangerous. Butter made from unpasteurized sweet cream may carry the brucella germ for 8 weeks or more. Undulant fever caused in man by brucella is a serious and often fatal disease. Fortunately the test and slaughter method now being carried on by the U.S. Bureau of Animal Industry is greatly reducing the prevalence of brucellosis.

Texas Fever, an infectious disease caused by a protozoan blood parasite, known as *Pyrosoma bigeminum*, transmitted to cattle and other animals through the agency of the cattle tick (*Boophilus annulatus*), has been exterminated in the U.S. by a campaign of tick eradication conducted cooperatively by the Bureau of Animal Industry and State authorities. No case of the disease has been reported since 1939. In 1906, when the campaign was begun, the quarantine line extended from central Virginia across the country to California. Fourteen States south of that line were infested with cattle ticks. Today the cattle tick is a thing of the past except in a small area of an Indian reservation in southern Florida, and a narrow fringe along the Rio Grande in Texas.

For many years after the start of the campaign this achievement was considered impossible except by some of the most optimistic of the veterinarians in charge of the work. To the credit of such men must be placed the eradication of 3 serious live-stock pestilences: contagious pleuropneumonia, nine outbreaks of foot and mouth disease and Texas fever. During the progress of the Texas fever campaign several methods of attack were perfected including immunization, pasture rotation to kill the ticks by starvation, and repeated dipping in an arsenical solution all tick infested cattle. The dipping method gave the coup de grace to the ticks. The original discovery in 1889 by the Bureau of Animal Industry that Texas fever was carried by the cattle tick was the first demonstrated instance of an insect agency in transmitting a disease to mammals. It led to the further discoveries of the connection of mosquitoes with malaria and yellow fever, tsetse fly with sleeping sickness and other diseases involving double hosts. Further details regarding Texas fever would be superfluous, since stock raisers will have no occasion to see cases of the disease.

Blackleg, also called black quarter or symptomatic anthrax, is an infectious disease characterized by the development of tumors in the muscles of various parts of the body, and is due to the presence of a bacillus. The disease is mostly confined to cattle, but cases have been known in sheep, goats, horses and dogs. Man is immune to blackleg. Cattle between 6 months and 18 months of age are most susceptible, sucking calves and old animals being less subject to the disease. Blackleg usually runs its course rapidly and is ordinarily fatal. The dry spores of the blackleg bacillus may be carried in hay or other feed, and animals may be infected by eating such material. The blackleg bacillus, however, usually gains entrance to the body through wounds in the skin, mouth, tongue or throat.

The symptoms of blackleg are loss of appetite, dullness, debility and high fever. These symptoms appear in from 1 to 3 days after infection has taken place. A lameness or stiffness of the legs is usually noticed, due to muscular swellings. Death occurs within 1½ days after the first appearance of the symptoms. Blackleg is distinguished from anthrax by the development of characteristic tumors, which emit a crackling sound when stroked. After death from blackleg, blood and yellowish material filled with gas bubbles may be found in these tumors. In anthrax the spleen is much enlarged and the blood does not clot freely, while in blackleg the spleen is not affected and the blood clots readily. The carbuncles and swellings of anthrax differ from those of blackleg in not containing gas and in causing death less rapidly.

Treatment by drugs is usually unsuccessful and is not to be recommended. Good results have attended the use of vaccine in preventing the development of blackleg. Vaccine for this purpose has been produced and was formerly distributed by the Bureau of Animal Industry, and reports from different parts of the country indicate that it is a practical and efficient means of controlling the disease.

Actinomycosis, also called big jaw,

lumpy jaw and wooden tongue, is an infectious disease due to the action of a parasitic organism known as the ray fungus. This fungus causes local affections in the form of tumors of the bone and other tissues. The disease is common in cattle, but affects also man, horse, pig, sheep and deer. The parasitic organism is found in all tumors and abcesses of the disease. Its presence may be detected with the naked eye or with a small hand lens in the form of minute yellow spots in affected tissues. The most common location of the disease is in the bones of the upper and lower jaw, the salivary glands at the angle of the jaw, and in the region of the throat. Tumors may also be found upon the tongue and the mouth. The disease is occasionally observed in the lungs and alimentary tract, and is perhaps sometimes mistaken for tuberculosis. The ray fungus finds entrance to the animals through wounds or abrasions of the skin or internal mucous membranes. A large proportion of the cases of actinomycosis develop tumors only in the jaw bone or other structures of the head, and it is probable that the ray fungus often becomes first established in wounds of the mouth or through decayed teeth. As the disease progresses the parasitic organism invades all parts of the body, producing tumors, some of which result in running sores, especially when the lymphatic glands of the skin are attacked.

The first treatment adopted in combating the disease was the removal of the tumors by means of the knife or with caustic applications. Subsequent experiments in Europe and in the United States demonstrated that actinomycosis may be successfully treated with iodid of potash. The proper dose of this substance is from 8 to 12 grams, according to the size of the animal. This dose may be given daily for from 5 to 6 days, when a mucous discharge from the nose and eyes will be noted. The treatment should then be interrupted for 2 or 3 days, at the end of which time another week's treatment may be given. Iodid of potash should be administered in solution in water in the form of a drench.

The organism which causes this disease is believed to be a degenerated form of a fungus which grows naturally upon feeding stuffs or grain, and it is thought that when the spores of the original fungus are taken into the digestive tract they gain entrance to the tissues and produce the disease.

Foot and Mouth Disease. This disease is common throughout Europe and other foreign countries. Strict quarantine measures, however, prevented its introduction into this country until 1903, when a quite serious outbreak occurred in New England, involving several States. The United States Bureau of Animal Industry, assisted by State authorities, as once began a campaign of quarantine and eradication, and carried it out with complete success. The method consisted in killing and burying or burning diseased animals, for which an indemnity was paid to the owners.

The disease is highly infectious, the virus being found in eruptions in the mouth and on the feet, in the milk and other products of diseased animals. It is most prevalent in cattle and swine, but goats, sheep, horses, dogs, cats, fowls and man are sometimes affected. The death rate is low. The chief symptoms are rise in temperature, loss of appetite and salivation, followed by eruption of yellowish blisters in the mouth and on the tongue and lips. The feet and udder may also be affected. The blisters soon burst and large quantities of stringy saliva are discharged from the mouth. Ordinary cases usually recover rapidly—within 10 to 20 days. The disease may be complicated with catarrh, pneumonia and loss of the hoofs, in which cases the usual outcome is death. The milk of cows affected with foot and mouth disease is very dangerous for children as well as for calves or swine.

The best method of eradication consists in strict quarantine, destruction of diseased animals and thorough disinfection of premises where the disease has occurred. Between 1870 and 1929 nine outbreaks of the disease have occurred in the U.S. and each outbreak was wiped out by quarantine and slaughter.

Milk Fever, as stated by the Bureau of Animal Industry, is a disease that generally attacks mature cows that have had 3 or 4 calves. It usually occurs within 3 days after the cow calves. It may, however, attack any cow at any time during her lactation period or a day or two before calving. High producers or fat cows are more subject to milk fever than low producers or thin cows. It is thought that plenty of water and salt and very little concentrated feed for several days before and after calving will help prevent this disease.

Milk fever may be recognized by the cow's staggering gait and lack of control of her hind legs. As the disease progresses

the cow goes down in a stupor, lying in a normal position, except that her head is usually turned to her flank. Later paralysis may become general, and then the cow lies on her side.

One method of treatment consists of inflating each quarter of the udder with air filtered through a liquid or cotton. Almost any sort of air pump will serve to force the air into the udder. Every dairyman should keep a milk-fever outfit on hand for quick use. Satisfactory outfits can be bought, or they can be made at little expense from a bicycle pump, rubber tubing, a piece of large glass tubing in which to place the cotton, and a milk tube. Care must be exercised to have the milk tube sterile, and the ends of the teats should be cleansed with a disinfecting solution. After inflation the teats should be tied with tape to prevent escape of the air. Ordinarily one inflation is sufficient, but in case the cow shows no improvement in 2 hours the inflation should be repeated. See that the cow lies on her brisket rather than flat of her side. Bags or bales of straw or hay can be used to prop her in position.

Another method of treatment consists of injecting calcium gluconate intravenously. This is the preferable treatment since it elminates the possibility of infecting the udder, which sometimes occurs when the udder is inflated with air.

Mammitis, also called garget, inflammation of the udder, or mastitis, is a disease of the udder common in cows which are heavily fed at the time of calving. It is especially frequent in heavy milkers. The udder becomes enlarged, hot and dense. A more or less pronounced congestion of the udder is almost always present at the time of calving, and this condition may be aggravated by standing in drafts or by neglecting to milk for a day or two. In such cases the milk may have a reddish tinge or may contain blood partly clotted. When withdrawn the milk may have a yellowish appearance, due to separation of the casein in it. In the more acute cases a fever temperature may be established, the flow of milk is decreased and the cow gives evidence of pain in milking. If the condition is not relieved abscesses may form in the udder, and one or more quarters may cease entirely to secrete milk.

In treating this disease the milk should be drawn frequently and hot poultices applied to the udder. A soothing ointment may be rubbed on this organ. The following formula has been much used for this purpose: 8 ounces of vaseline, 3 ounces each of extract of belladonna, gum camphor and extract of henbane. If the udder becomes hard it may be rubbed with an ointment containing 1 dram each of iodin and iodid of potash and 4 ounces of potash. During an attack of mammitis the diet should be light and a purgative of Epsom salts may be given to reduce the temperature.

In cases where mammitis is associated with evidence of constitutional disease in the animal, and where it persists for a long time with pus in the milk, tuberculosis of the udder is to be suspected. The disease is usually due to injuries of the mammary gland or retention of the milk. Sometimes, however, it is of an infectious nature, and in such cases great care should be exercised in preventing a spread of the disease through the milk which is removed from affected udders.

Bloating, also called tympanites or hoven, is produced by the formation of gas in the first stomach. It may be caused by eating any kind of food which produces indigestion. Usually, however, the trouble is due to eating corn, alfalfa or clovers. According to some stock raisers, the danger from eating such plants is especially great when the dew is on, or immediately after a frost. Cattle gradually acquire an immunity to such danger, and after being pastured for some time on alfalfa or clover are not so apt to be badly affected. In the treatment of bloating large doses of soda dissolved in water may be administered with melted lard or other harmless oil. When the pressure upon the inside of the stomach has become so great that the animal cannot walk, it is necessary to resort to paunching. This operation consists in making an opening in the stomach, directly through the body wall, and may be accomplished by means of a thrust with a knife or by the use of a trochar and canula, which may be obtained from dealers in veterinary instruments. The point for making the incision is described as equally distant from the last rib, the hip bone and the side processes of the vertebral column upon the left side of the animal.

Cowpox, also known as variola, is an infectious disease of cattle characterized by fever, falling off in the milk yield and the appearance of pustules on the teats and udder. The disease ordinarily runs a harmless course and is quite prevalent, especially in the Eastern States. It is not transmitted except by contact. A

similar disease affects horses and sheep. As should be well known, the virus obtained from the pustules of cowpox is used in vaccinating man against smallpox. The virus produces a mild form of the disease, from which man recovers in a few weeks and is then immune to smallpox. If it becomes necessary to treat the teats and udders of cows, good results may be obtained from the use of some antiseptic wash or ointment such as carbolized vaseline or iodoform ointment.

MILK SICKNESS, or trembles, is a disease that attacks persons and lower animals alike. It is due to a poisonous substance, tremetol, present in certain poisonous plants.

In the eastern portion of the country white snakeroot is the plant that carries tremetol. In the Southwest, jimmyweed and a closely related plant, *Aplopappus fruticosus*, furnishes the poison.

The poison is secreted in the milk of animals that have grazed on these plants and such milk is capable of causing the disease in persons and sucking animals. The disease can be prevented by keeping live stock away from the plants either by fencing off the areas where the plants grow or better, by destroying the plants.

OX WARBLE. "Experiments conducted by the Bureau of Entomology and Plant Quarantine, as well as actual ranch practice, have shown that the abundance of cattle grubs (*Hypoderma lineatum* and *H. bovis*) can be greatly reduced and the annoyance by the adults, or heel flies, very largely elminated by applications to the backs of infested cattle of a wash containing powdered root of either derris or cubé, or by applications of a dry dust consisting of the powdered root and wettable sulfur. The application should be made before any of the grubs drop from the backs and should be repeated about once a month during the season when the grubs are present in the backs of cattle. For the larger herds of cattle the wash can be diluted and applied more rapidly and economically with a power sprayer.

"The applications must be thorough. Each treatment results in the destruction of about 95 per cent of the grubs present at the time. Some of the dead grubs are forced out of the sacs. The dead grubs that remain under the skin are absorbed in a few weeks.

"The grubs ('warbles' or 'wolves') in the backs of cattle are the young, or larvae, of the heel flies. When the grubs have attained their full growth in the back each grub crawls out of the pocket, or cyst, which it has occupied for 5 weeks or longer and drops to the ground. On the ground it pupates as promptly as climatic conditions will permit, and 4 or 5 weeks later the pupa changes into a heel fly. The female fly goes to the cattle merely to lay her eggs and she lives only a few days. Usually the eggs are laid on the hair around the hoofs, but occasionally they may be laid on hair along the belly and escutcheon. In a very few days the eggs hatch, and the tiny larvae, or grubs, burrow through the skin near the base of the hair upon which the eggs were laid. Having thus effected an entrance, the young grubs pursue a devious course through the body of the animal, reaching the back about 9 months later. Each grub makes a hole in the skin of the back and remains in close contact with the opening, through which it gets air. In this location the grub completes its growth while the tissues of the host form a pocket, or cyst, around it. It is here also, before the grub escapes to the ground, that the stock owner has the best opportunity to destroy it. Being open to the air, the cyst may become contaminated with bacteria. Pus and swellings occur in many cases."

HORNFLY, (*Haematobia serrata*), was introduced from Europe and has become quite generally distributed over the country. It is smaller than the housefly but closely resembles the latter. The hornfly appears in swarms and is in the habit of collecting in great numbers upon the base of the horns. This habit has given them their name. They attack cattle, especially upon the flanks and shoulders, in places where they are not easily warded off.

"Stable flies and hornflies are not attracted by bait, but they may be killed by a spray. A cheap and effective killing fly spray may be prepared by suspending for 24 hours or longer a 5-pound bag of half-closed pyrethrum flowers in 9 gallons of kerosene and 1 gallon of furnace fuel oil of 28° to 32° gravity. This mixture is applied with a pump equipped with a nozzle to deliver a very fine spray over a considerable area. Not all the flies hit will be killed immediately, some seen flying away will soon die from the effects of the spray. Large dairies find it practical to use a power sprayer by means of which the barn can be filled with a fine mist when the flies have gathered. This sprayer, however, may be too expensive for use in small dairies. Flies may be sprayed while they are on the cattle, when

they are on the walls, or at places where they have gathered for feeding. If they are sprayed while on the cattle, care should be taken that the spray is directed parallel with the animal and that the animals are not brushed immediately afterwards, as the kerosene will blister the skin. Since hornflies stay on the cattle most of the time they are easily hit with the spray."

The eggs of hornflies are deposited in fresh manure, and maggots may be destroyed by covering the manure with lime.

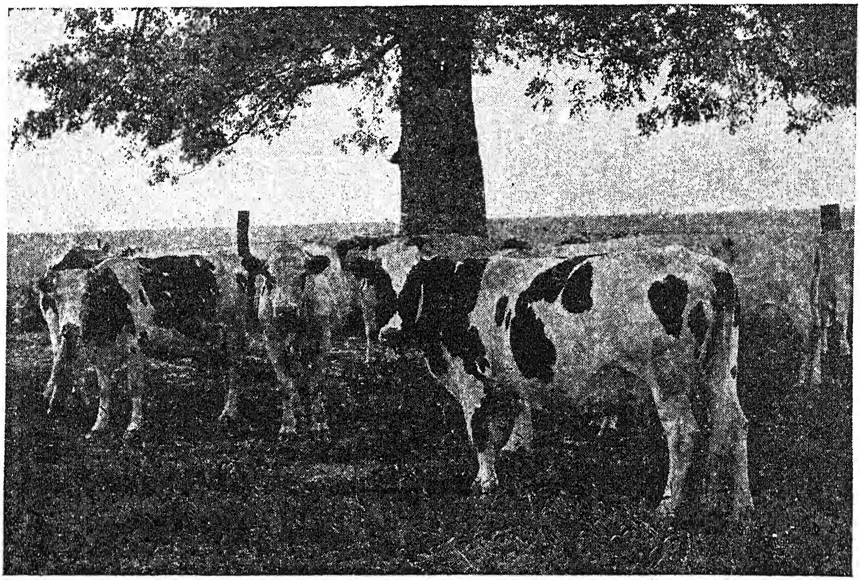
JERSEYS BY A FARM BROOK

DAIRY FARMING

The economic importance of dairying is sufficiently evident from the bare statement that our 26,303,000 milch cows produce a gross farm income of over 2⅓ billion dollars annually, and that 5⅓ million of our 6 million farms derive part of their cash income from dairy cows. During the past 20 years the number of cows kept for milk has never been below 20 million and the trend has been upward. The leading dairy States are Wisconsin, Minnesota, Iowa, Texas, New York, Missouri, Michigan and Pennsylvania, but every State has a substantial dairy industry.

Good dairy cows produce food in the form of milk more economically than animal products can be obtained in the form of beef, pork or mutton. In other words, a milch cow can transform a given quantity of hay, silage, pasture and grain into money more cheaply than the Hereford, the Berkshire or the Merino. Naturally the cost of production of milk and butter will vary in different localities according to the price of labor and feeding stuffs.

In making a practical start in the dairy business the first problem is the formation of a dairy herd. The selection of the cows and the bull is by no means an indifferent matter. It is usually recommended that a herd should not be composed of different breeds, but should contain only one pure breed and grades of that breed. For dairy purposes dairy breeds should be selected for the reason that they produce milk fat rather than body fat from their food, while beef types of cattle as a rule are likely to become fat under forced feeding without increasing their milk yield. One should not, however, allow either breed or type to determine his choice of cows for a dairy herd. The prime requisite is that they shall give a good quantity and quality of milk.



HOLSTEIN HERD

A good cow should yield 6,500 pounds of milk and 300 pounds of butter per year. But the national average is about 4,700 pounds. It will scarcely pay to keep for dairy purposes any cow which produces less than 200 pounds of butter per year.

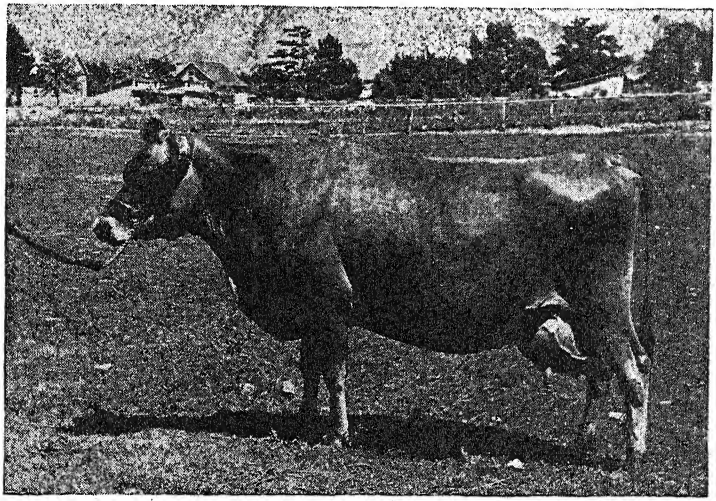
After selecting a herd the milk of each cow should be weighed daily and should be tested from time to time with a Babcock tester. In this way the dairyman keeps himself informed as to the productiveness of different cows and may cull out from the herd such cows as are not paying for their keep. The bull is a very important part of the herd. By using a good bull an excellent and productive herd may ultimately be secured from an average lot of cows. For discussion of calves, combination of dairying and beef

making, and temperature of cows *see Beef Cattle.*

Breeds. The breeds of cattle in this country most used for dairy purposes are Ayrshire, Dutch Belted, Guernsey, Holstein and Jersey. Some of the dual purpose breeds are discussed under Beef Cattle. Shorthorns are also very profitable for dairy purposes. In this place a few notes will be given on 4 only of the dairy breeds, viz., Holstein, Jersey, Guernsey and Ayrshire, mentioned in the order of their comparative numbers.

The GUERNSEYS are larger than the Jerseys and of stronger bone. The bulls are perhaps of better disposition than Jerseys. The color of the breed is light, chiefly yellow and orange with considerable white. There is an abundant secretion of yellow coloring matter on the skin particularly where the hair is white. The Guernseys are economic feeders and excellent butter producers, the milk often showing 5 per cent to 6 per cent of fat.

The AYRSHIRES are noted for their vigor and their ability to give good re-



RECORD JERSEY COW

turns in milk and butter even under unfavorable conditions of pasture, etc. Cows average about 1000 pounds in weight and bulls range from 1400 to 1800 pounds. They are short in the legs, of small bone and active. It is frequently claimed that they give the best returns for their feed of all the dairy breeds. The predominating colors are red and white, variously arranged in spots but not mixed. The cows are of a very nervous temperament and somewhat quarrelsome.

The HOLSTEINS are large for dairy breeds, the cows ranging from 1200 to 1500 pounds and the bulls often weighing 2500 pounds. The breed is distinguished by its pure black and white colors, the patches of each color being sharply defined. Holsteins are docile and are noted for their enormous milk yields. The average herd recorded is 7500 to 8000 pounds of milk per head per year and some cows yield as much as 30,000 pounds per year.

The JERSEYS are the smallest of the dairy breeds, the cows weighing usually from 700 to 1000 pounds and the bulls from 1200 to 1800. The color varies exceedingly, from brown to black and from shades of yellow through fawn and tan colors to creamy white. Solid colors are preferred by some breeders but the majority of Jerseys are variously marked. The breed is characterized by the high percentage of fat and other solids in the milk. Jerseys are heavy feeders and give a good account of their feed.

For the general differences between dairy and beef breeds *see Beef Cattle.*

Numerous experiments have been made for the purpose of determining whether a particular breed is uniformly better for the production of milk, butter or cheese than the other breeds. The results of these experiments, as well as the claims of the admirers of different breeds, are so much at variance that no unqualified recommendations can be made along this line. The choice of a breed for establish-

ing a dairy herd will depend, therefore, in large part on the personal taste and preferences of each individual. The following data from experiments in comparing breeds may be suggestive.

In a series of experiments at the Cornell Station it was found that individual cows of the same breed vary more in milk and butter production than do different breeds. At the Storrs Station experiments showed that "the type of a cow is a much better index of her ability for economical production than is her pedigree." Cows of good dairy type were more productive than other types without regard to breed. In Wisconsin a comparative test of the average daily milk yield gave the following results: Holstein, 48.9 pounds; Brown Swiss, 37.3 pounds; Shorthorn, 31.9 pounds; Guernsey, 28.9 pounds; Ayrshire, 27.7 pounds; Dutch Belted, 27.2 pounds; French Canadian, 27 pounds; Red Polled, 26.6 pounds; Jersey, 24.5 pounds; Polled Jersey, 22.9 pounds; and Devon, 11.8 pounds. In a test of the percentage of fat in the milk of different breeds, the Jersey stood at the head, followed by Guernsey, Polled Jersey, Devon, French Canadian, Ayrshire, Red Polled and Shorthorn. In a comparison of the cost of feed per quart of milk at the New Jersey Station it was found to cost 1.66 cents to produce a quart of milk from Ayrshires, 1.71 cents from Guernseys, 1.71 cents from Shorthorns, 1.75 cents from Holsteins and 1.91 cents from Jerseys. The cost of a pound of butter fat was 15.3 cents from Guernseys, 17.9 cents from Jerseys, 20.6 from Ayrshires, 20.8 from Shorthorns and 22.4 from Holsteins. At Toronto the breeds ranked as follows in quality of milk: Aberdeen-Angus, Hereford grade, Shorthorn grade, Ayrshire, Hereford and Shorthorn. In relative profit from milk at the New York State Station the breeds ranked as follows: Holstein, Shorthorn, Ayrshire, Guernsey, Jersey and Devon. In relative profit from butter the breeds stood in the following order: Guernsey, Jersey, Shorthorn, Holstein, Ayrshire and Devon. In relative profit from cheese the breeds ranked as follows: Shorthorn, Guernsey, Jersey, Holstein, Ayrshire, and Devon. In Iowa the cost of butter per pound was 10.4 cents from Jerseys, 12.7 from Shorthorns, and 12.8 from Holsteins. In a test at the New Jersey Station the percentage of fat in milk from Guernseys was 5.02, from Jerseys 4.78, Ayrshires 3.68, Shorthorns 3.65, and Holsteins 3.51.

HOLSTEINS IN ALFALFA

These experiments show that dairy cows should be selected not for their breed but for their ability to produce milk and butter in large quantity and with good profit for the feed consumed.

Effect of Dehorning. This operation is generally recommended by those who have tested the matter. Unruly cows are rendered docile and easily managed and there is less danger of injury to one another and to attendants. Only a slight check is observed in the milk flow from dehorning and the full yield is regained within a week or 10 days. In Minnesota the unfavorable effect upon the milk yield

was as marked in cows which merely saw the operation and smelled the blood as in cows which were dehorned. For details of the operation *see* under *Beef Cattle.*

Value of Shelter. Dairy cows require more shelter than beef animals, but shelter must not be furnished in the form of unsanitary confinement. Stables for cows should have no cellar under them or storage above the cows unless the ceiling is dust proof. There should be no material in them which may absorb odors from the cows or develop bad odors by decomposition or fermentation. If stables are used exclusively for stables they may be easily cleansed and disinfected at frequent intervals by use of whitewash or other material. The stable should be in immediate connection with the barn in which the feeding stuffs are stored. I cannot in this work describe model arrangements which should be found in a dairy farm and stable. The ruling idea in the construction of the barn should be convenience in storing and handling feeding stuffs, while the stable should be built with a view to securing the greatest possible cleanliness of the cows and their surroundings.

In Indiana it was found that cows ate more and gave less milk when exposed to severe weather than when kept in stables. Cows out of door also lost weight. In Massachusetts warming the stables had little influence on the yield of milk and butter. Stabling cows to protect them against flies in summer was found to have no advantage in Wisconsin. In Arizona cows exposed to winter rains showed a decrease of from 10 to 50 per cent in milk flow, and required a month to return to their normal yield. Exposure to summer rains also had a bad effect. In the dry cold weather of winter more feed was required than in warm weather.

Dairymen in New Zealand and Australia told me that it pays to blanket cows at pasture with a burlap covering during most of the year. The cost of the burlap "rug" is about $5 a year but the increased milk yield more than offsets that expense. The cows are not annoyed by cold rains and the yearly hair shedding takes place with less irritation.

Feeds and the Time of Year. Experiments at the New York Station showed that cows required the greatest amount of feed in July, when the quantity was nearly 3 times as much as in May. The amount required for June and September was about the same but less than for July.

Relation of Amount of Feed to Economy of Production. As a rule cows that eat the most feed produce the most milk and butter, and make these products most economically. The fact has been demonstrated in New York, Pennsylvania, and in other official tests at the World's Fair in Chicago. The feeding power of cows is, therefore, an important matter to be considered in selecting or breeding up a dairy herd.

Age and Productivity of Cows. Dairymen usually find that the milk yield increases up to about 7 years of age, after which it remains nearly constant until about the 12th year, when it begins to decrease more rapidly. The average dairy cow is at her best between the ages of 7 and 10 years. There is usually a slow and gradual decline after the 7th year of life until the 12th year, after which the cow may be less profitable than heifers. After that period of profitable milk production is passed, dairy cows should be kept dry and fattened for beef. At the Cornell Station it was found that the cost of milk was greatest in 2-year-old heifers and decreased up to 4 years of age, after which it remained constant. The gain in milk yield between the ages of 2 and 3 years was 5 per cent, between 3 and 4 years 18 per cent, and 15 per cent between 4 years and the age of greatest production. At the Ohio Station it was shown that the cow gives a constantly increasing milk yield for a given amount of feed up to 7 years of age, after which a slow decline was observed until the 11th year of age.

Relation of Size of Cows to Milk Yield. In a comparison of light, medium and heavy cows at the exposition in Chicago, as reported by Woll, the light cows yielded the least milk and butter and their feed also cost least. The results were slightly in favor of the heavy cows. Some German experiments indicate that the milk of small cows is richer in fat but that the quantity is relatively smaller than in large cows. The latter eat less feed per 1000 pounds live weight that small cows.

Period of Lactation and Milk Yield. Experiments in New York, Wisconsin and Ohio show that the greatest production of milk fat takes place soon after calving and that the flow is gradually diminshed. The New York State Station found that the milk yield for each month was about 9 per cent less than that of the preceding month.

Fall Calving. There are many advantages to be derived from having the calves come in the fall. The greatest milk yield

is obtained if proper feed and care are provided during the winter. The highest prices are obtained for milk and butter in winter. Cows which calve in the fall may obtain fair feed on pasture and this may be supplemented by soiling or feeding silage. Silage and roots may be fed during the winter, and a fresh flow of milk may be induced by turning the cows to pasture in the spring. In winter the farmer has less exacting work to take his attention from the necessary care of the cows than in summer. Fall calving is also better for the calves. They are less subject to scouring in winter than in summer and spring pasture is ready for them by the time they are weaned. They, therefore, suffer no check in growth, and may be conveniently and profitably forced for the production of "baby beef." (*See Beef Cattle.*)

PUREBRED HOLSTEINS IN NEBRASKA

Treatment of Cows Before and After Calving. As a rule the greatest total milk yield for the year may be obtained by drying off the cows from 6 to 8 weeks before calving. This may be accomplished with most cows by withholding the stimulating grain ration, milking once a day and later every other day. Attention must be given to the condition of the udder during this period so as to prevent inflammation. Some cows, however, apparently cannot be made to go dry and do not require the period of rest before calving. At this time the bowels should be kept loose. A good grain ration for a few days before calving is a mixture of ⅔ bran and ⅓ linseed meal. This mixture may also be continued for the first 2 weeks after calving. The roughage may be alfalfa or clover hay and roots.

After calving the cow should be kept warm, by blanketing if necessary, and should not be allowed to drink ice-cold water until the afterbirth has come away. If this does not occur from 24 to 48 hours after calving, it should be carefully removed by hand. A vaginal douche of a dilute solution of permanganate of potash (5 to 10 grains in a quart of water) may be given to prevent any irritation or rise of temperature. The calf should be allowed to suck the cow for 4 or 5 days, after which he may be separated from the cow and fed at first on whole milk then on sweet skimmilk and grain. (*See* under *Beef Cattle.*)

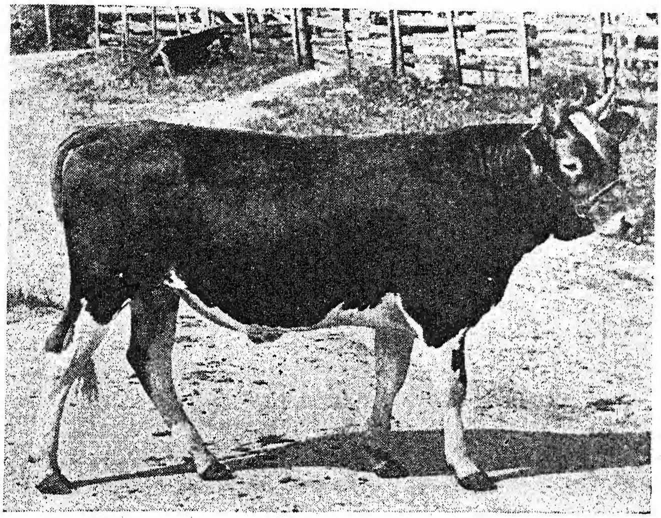
If a case of caked udder or garget develops the cow should be milked frequently, say at intervals of 2 hours, but not dry. Epsom salts may be given as a laxative in a dose of 1 or 2 pounds dissolved in water. It may become necessary to make moist, hot applications to the

udder. (*See Mammitis* under *Beef Cattle.*)

Exercise. It is generally recognized that for the best results with cows some exercise is necessary. In summer this is easily provided in pasture or feed lot if soiling is practiced. In winter it may be necessary to provide sheds in which the cows may move about, protected from too great exposure to cold. No animal can maintain a good state of health and vigor for 10 or more years without some regular exercise. The percentage of tuberculosis in dairy cows is far greater than in beef cattle, and this is partly due to excessively close confinement of dairy cows.

Kindness, Regularity, etc. The high bred dairy cow is of a nervous temperament and any fright or excitement from rough treatment or other annoyances has the effect of lowering the milk yield. Moreover the flow of milk is favored by regular hours of feeding, milking, grooming, etc. There should be no unnecessary changes in the attendants who feed and milk the cows.

In Michigan it was found that "No general recommendation can be made that all dairymen milk their cows three times daily instead of twice because on many farms this would greatly aggravate the present labor shortage, and with lower producing cows it would be questionable economy. However, the higher-producing cows, if regularly milked three times instead of twice daily, can be expected to produce 15 or 20 per cent more milk and fat. Milking four times daily, then, would furnish an additional increase of 6 to 8 per cent. This offers an opportunity for any dairyman who may have the labor available. For greatest benefits in the extra milkings, the schedule of milking must be adjusted so that the intervals between milkings will be as nearly equal as possible. Perhaps, however, if surplus labor is available it may be more efficiently used in milking more cows, rather than spending so much time on one cow."

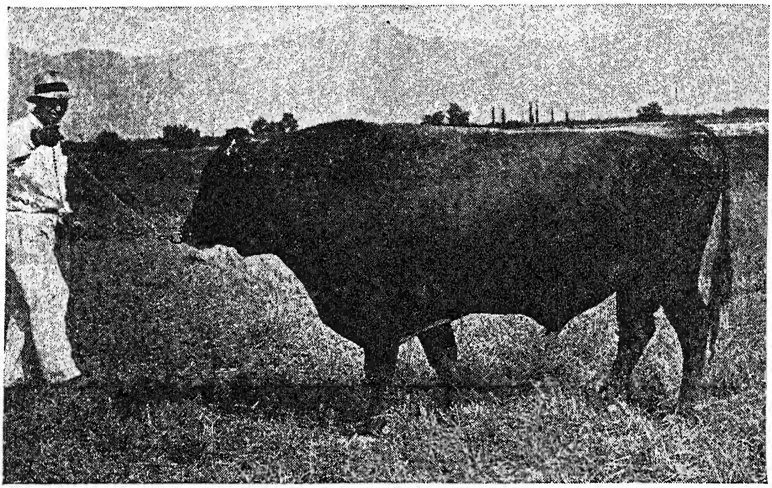


YEARLING GUERNSEY BULL

Care of the Bull. The bull should be given plenty of exercise and nitrogenous feeds. He should be kept at pasture for the greater portion of the year, in a field by himself, and in winter may be allowed the run of a small lot with shed protection from storms. Vigor and not fat are desired in a bull. He should therefore receive good roughage in the form of alfalfa or clover hay and bran, oats, peas or barley rather than corn. The bull is perhaps at his best between the ages of 2 and 5 years, but may be useful for a few years longer if not allowed to become run down by overservice.

Artificial impregnation was first practiced in horse and mule breeding where it was found that sufficient semen could be obtained from one service by a stallion or jack to impregnate six or more mares. More recently the method has been successfully followed in breeding dairy cattle. The New Jersey Experi-

ment Station reports that 800 dairymen have derived benefit from cooperative breeding associations. "They thus obtain the use of extraordinary sires at little or no extra cost. The membership of 5 groups are breeding 7000 cows to 22 bulls of outstanding quality. They may relieve themselves of the bother and danger of keeping a bull." The expense of veterinary inspection of the bull is borne by the association and the danger of spreading a disease, such as infectious abortion, is thereby obviated.



JERSEY SIRE

Pasture. Almost every farm has one or more pasture lots. Pastures may be seeded to cultivated grasses and in the arid regions may be irrigated, or they may represent waste areas which cannot be tilled. While pasturage is at its best a good milk flow can be obtained with only small grain rations. Experiments indicate, however, that it is always desirable to feed some grain to cows at pasture, even when the grass is greenest and most succulent. Pastures may be reenforced at any or all times by feeds of soiling crops after milking, and when the pasture becomes short the rations of green crops must be correspondingly increased. The chief advantages of pasture are that the cows secure succulent feed under cleanly and healthful conditions combined with a proper amount of exercise. Close attention should be given the cows late in the season, since wild pasture may suddenly become quite inadequate for the maintenance of the milk flow in periods of drouth. For grasses suitable for improving pastures *see* under *Grasses*. A change from dry feed to pasture or vice versa should always be made gradually so as not to interfere with the milk flow.

In Louisiana March to June inclusive "were the high months both in production per cow and in returns over feed cost. These are the months when good pastures are usually available. The poor pasture months of November and December ranked lowest in production." In Oregon the total cost of pasture per cow ranged from 6 to 8 cents per day, and the length of the pasture season varied from 209 to 239 days per year, depending on the grass mixture.

Experiments in Oregon showed that "pasture plants are the natural feed of livestock. The countries of the world that have the rainfall and climate conditions essential for the growing of pasture and other forage are the leaders in livestock production. As values increase on the more productive land, there is a tendency for the dairy cow to replace the meat- and wool-producing animals.

"Good pasture usually furnishes feed for the dairy cow at a lower price than any other farm crop. It is more economical than the other roughages, such as hay, silage, roots and soiling crops, because of the higher yield and greater digestibility of the dry matter of pastures and because there are no harvesting costs and comparatively low seeding and tillage costs.

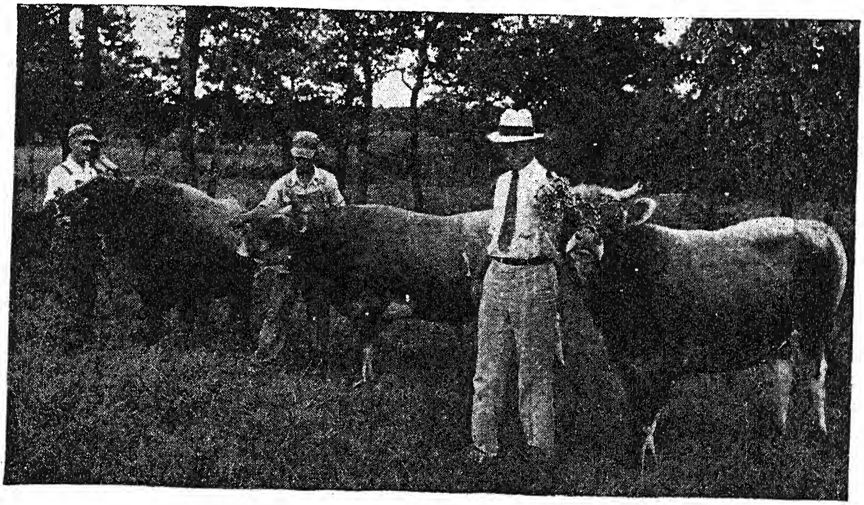
In addition to supplying a low-cost feed, the barn labor cost of producing milk or butterfat is lower when cows have good pasture than when stall feeding of roughage is necessary.

"In addition to supplying nutrients cheaply, pasture furnishes the right kind of nutrients for the good health, milk and butterfat production, and reproduction of the cow. Immature plants are much more palatable and the dry matter is higher in protein, minerals and vitamins than are the same plants when more mature."

In Canada pasture produced more and better milk than soiling on alfalfa, rye and oats. At the Vermont Station it was shown by experiments extending over a period of 6 years that a change from barn to pasture produced an increase in the solid matters in milk, especially in new milch cows. In New York drouth affected cows on pasture by diminishing the casein and increasing the fat in the milk. There are greater returns from stall fed than from pastured cows. At the New Hampshire Station it was found that pasture grass increased the quantity of milk and its fat content. In Utah grazing on pasture of mixed grasses under irrigation proved to be the most economical way of producing milk. A change from dry feed to pasture gave a greater increase in milk than a change to soiling. The composition of the milk was not affected by pasture. (*See Pastures* in *Field Crops*.)

Soiling. This practice has long been familiar to farmers, but has greatly increased of late years and found many enthusiastic advocates.

Soiling is the practice of raising various forage crops to be cut green and to be fed in this condition to animals. By a system of soiling instead of pasturing, an increase in the productive acreage of the farm is secured, a much greater amount of forage is produced on a given area of land than by pasturing, less land and less grain are required, the land is maintained in higher state of cultivation and fertility, and the manure is preserved.

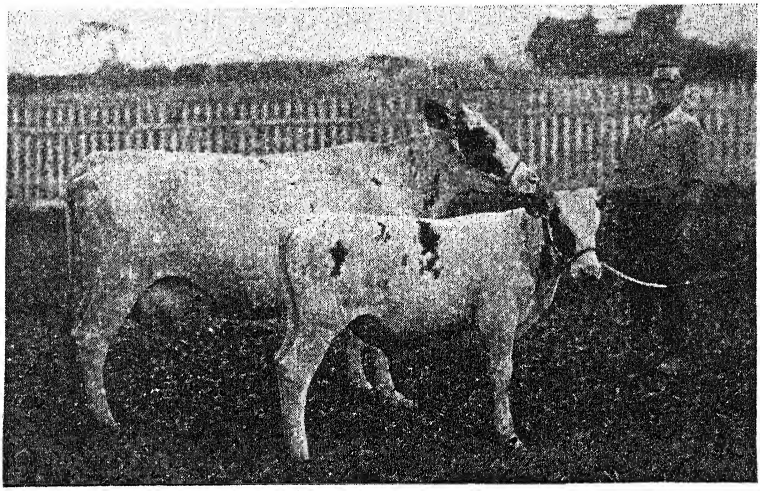


PUREBRED JERSEYS

As the price of farming land increases, especially in the neighborhood of cities, it becomes unprofitable to hold large areas of arable land for pasture. Several experiment stations have tested the system of soiling and report favorably upon it both as the exclusive method of summer feeding and for supplementing pasture late in the season when pasturage is short and dry. No extra expense is incurred in introducing the system upon a farm and no machinery other than that ordinarily possessed by farmers is required.

In order to have green crops for soiling during the whole season from early summer till fall, it is necessary to adopt a suitable rotation of soiling crops. With the exception of corn and sorghum, soiling crops do not remain at their best for more than about 10 days. It may, therefore, be desirable to sow a portion of each plot of land at weekly intervals. Wheat and rye may be sown in the fall and will be

ready to feed during May and June of the following season. In the spring barley may be sown as early as possible, followed by 4 or 5 sowings of oats and peas at weekly intervals. These will serve as soiling crops for July. At the time the last sowing of oats and peas is made, corn or corn and sorghum may be sown and will be ready for use in August and September. The ground occupied by the oats and peas will be free by the end of June and may then be sown to millet and barley for use in the latter part of September and first part of October.



PUREBRED AYRSHIRES

In Connecticut it was found that soiling was always necessary to help out when pasture was short. Legumes like clover, peas and soy beans proved better than corn fodder and other soiling crops. In Iowa soiling proved superior to pasture. Cows ate about 75 pounds of green feed per day in addition to grain. In Massachusetts rye, vetch and oats, peas and oats, corn fodder, and serradella are recommended for soiling, and in New Jersey rye, corn, crimson clover, oats and peas and millets. In Pennsylvania the cost of soiling proved so great that good prices for milk were necessary to make it pay more than pasture. At the Wisconsin Station 3 times as much milk was produced by an acre of soiling crops as by an acre of pasture. At the New Jersey Station it was found that by a proper system of rotation a continuous supply of green forage could be obtained from May 1 to November 1, and that 7 acres of land would produce enough coarse fodder for 25 cows. According to this system rye and crimson clover are sown together in September to be cut the next year, May 1 to 10. Oats and peas are sown on this acre May 10 to be cut July 1 to 10. Soy beans are sown July 10 to be cut September 1 to 10. On the second acre there is a rotation of wheat, cowpeas and Japanese millet, on the third crimson clover and corn, on the fourth mixed grasses and corn, on the fifth oats and peas, Japanese millet, barley and peas, on the sixth oats and peas, cowpeas, barley and peas, and on the seventh corn alone. The various crops are sown at such times and in such rotation as to furnish a continuous supply of forage. This scheme is mentioned simply as one example of a successful system of rotation of soiling crops.

Of the various crops which were tested at the New Jersey Stations in soiling experiments, alfalfa, rye, corn, crimson clover, oats and peas, and the millets gave the most profitable returns, while red clover, cowpeas, soy beans are also recommended. In addition to the plants just mentioned various others have been successfully and profitably grown as soiling crops. In this connection mention should be made of wheat, mixed grasses, teosinte, Kafir corn, sorghum, vetches, rape, etc.

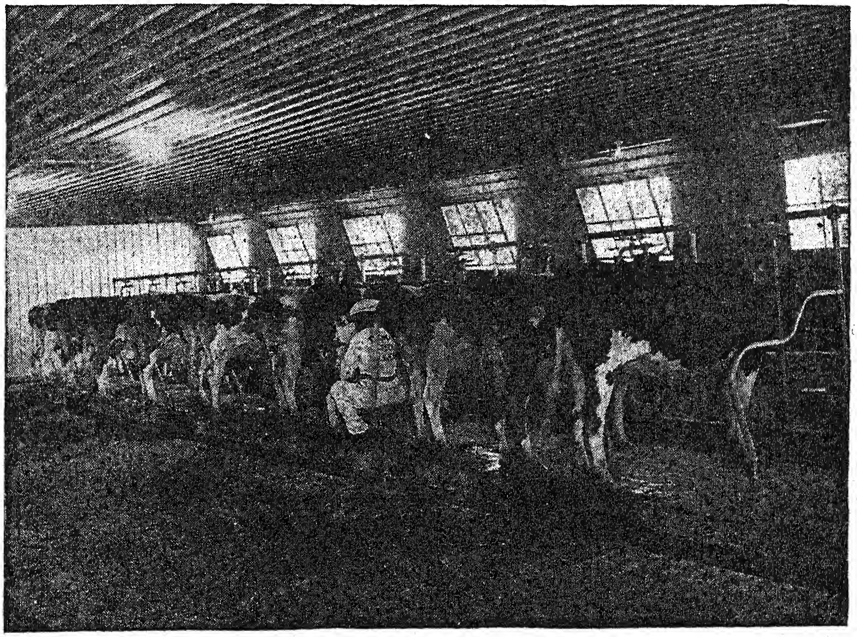
At the Pennsylvania Station it was found that from 3 to 5 times as much forage was produced on an acre from soiling crops as from pasture. Similar results were obtained at several other stations.

Moreover, these conclusions are abundantly corroborated by the practical experience of the many dairymen who have adopted the practice of soiling. An intensive system of soiling will impoverish the soil if occasional crops are not turned under, leguminous crops frequently sown or plenty of manure returned to the soil.

Where leguminous plants have been directly compared with other plants, as at the Connecticut Storrs Station, they have proved superior. This is in accord with the findings of most investigators that a highly nitrogenous ration is most effective in the production of milk.

Soiling has found its widest application as a system of feeding milch cows. Some experiments have indicated that it is not profitable as applied to the feeding of pigs. Soiling was compared with pasture and feeding of hay at the Utah Station with the result that for fattening steers less feed was required for a pound of gain by soiling than from pasture or hay. Perhaps the best soiling crops for sheep are rape, vetches, alfalfa and oats and peas. A soiling system may also be adopted in feeding brood mares and colts.

Green forage may be fed in stable or yards according to the estimated importance of exercise in any particular case, and the convenience of feeding. At the New Jersey Station it was found that cows would eat about 60 pounds green forage per day in addition to a grain ration. Animals should be fed only as much as they will clean up, or if any fodder is left it should be taken out of the feed box before feeding again. It is recommended by Peer that dairy cows be fed 4 or 5 times per day.



MODERN DAIRY STABLE

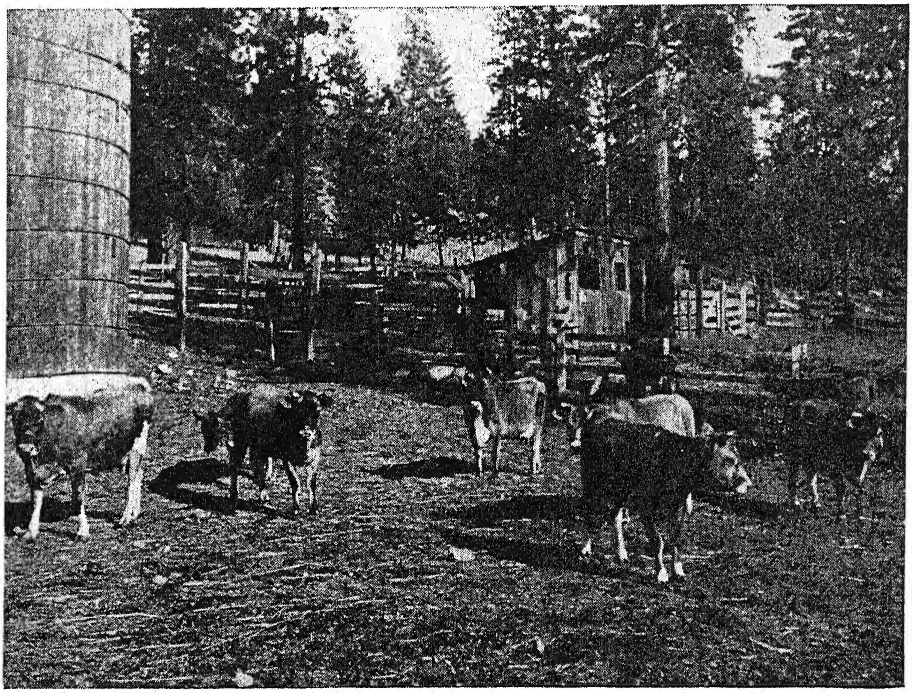
Forage crops and Roots for Cows. Notes will be given in the following paragraphs on various forage and root crops suitable for dairy cows. The crops are arranged alphabetically, forage plants first followed by roots.

Alfalfa is one of the most important forage plants for cows in the arid regions. It may be pastured or fed as hay or a soiling crop. In Canada alfalfa was eaten with more relish than green rye and gave the butter a better flavor. In New York alfalfa produced more milk than any other green forage or silage. The quality of the milk was sometimes poorer than that of milk from corn fodder or silage. Alfalfa proved superior to mixed hay in Utah, and was cheaper and more effective than corn fodder. In New Jersey it was found that alfalfa hay could be substi-

tuted for wheat bran or dried brewers' grains in rations for dairy cows.

According to the Pennsylvania Experiment Station, "alfalfa-molasses silage (80 pounds molasses per ton) and soy bean-molasses silage (120 pounds molasses per ton) are of equal feeding value for milk production when fed in a ration with corn silage and hay. On account of the high cost of soy bean silage, it is not advised except in an emergency when alfalfa or other legumes are not available. Ensiling lactic acid than when it is preserved with phosphoric acid. In cases where alfalfa has a higher initial sugar content, phosphoric-acid silage may be of as high quality as would result with molasses as preservative.

"When legumes are cured into hay, a large part of the carotene and other nutrients may be lost through shattering of leaves and bleaching. Ensiling avoids practically all of this loss. After several months in storage, the carotene in legume



DAIRYING ON CUT-OVER LAND

soy beans is usually preferable to curing for hay. Legume silage, especially the first cutting of alfalfa, is highly satisfactory as supplementary feed for dairy cattle on short pasture in late summer or in drouth period. On most farms, especially in central Pennsylvania, the practice will result in saving considerable alfalfa that is usually lost because of unfavorable haying weather in June.

"Fermentation studies of third cutting alfalfa reveal that quality of silage, based on lactic acid production, improves as the amount of molasses for preservative is increased from 40 to 120 pounds per ton of green forage. As a general rule alfalfa preserved with molasses produces more silage tends to decrease appreciably. This decrease varies widely, but in general a good grade of legume silage in storage 7 months will supply from 3 to 6 times as much carotene on a dry matter basis as alfalfa hay of good grade. Tests to date indicate that the carotene in legume-phosphoric acid silage tends to deteriorate rapidly after being in storage 5 to 6 months. The rate of decline is not nearly so pronounced in alfalfa-molasses silage, and several tests have revealed from 3 to 5 times as much carotene in alfalfa-molasses silage as in alfalfa-phosphoric acid silage after 7 months of storage."

BERMUDA GRASS HAY has been found equal to timothy for milk production.

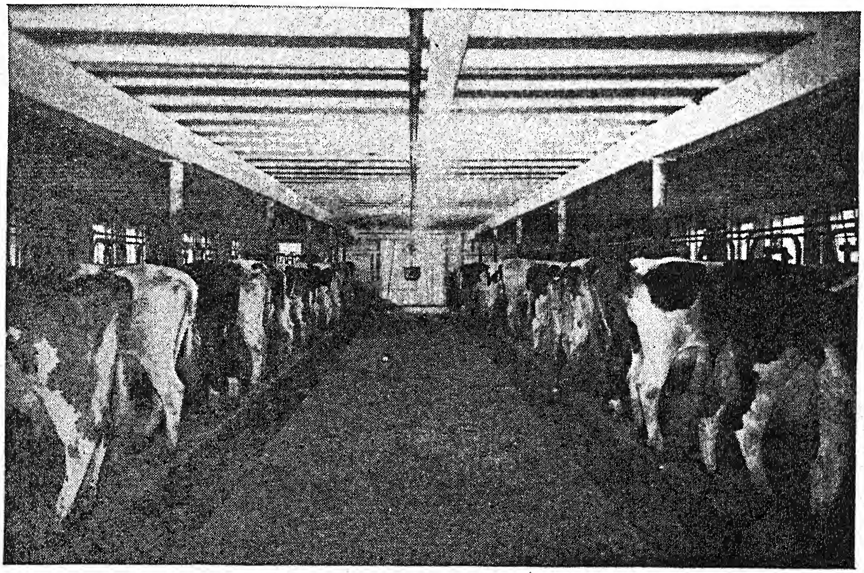
The grass is used extensively for pasture in the Southern States.

Brome Grass starts early in the spring and is much relished by cows. In New Hampshire brome grass pasture proved to be not quite equal to alfalfa or to a mixture of blue grass and white clover.

Clover occupies the same place in the eastern half of the country as does alfalfa in the west. It may be pastured or fed green, as hay or as silage. In Vermont clover silage proved unequal to corn silage. At the Storrs Station clover was found to be superior to Hungarian grass for milk and butter production. Red clover proved about equal to peas and oats as a soiling crop in Iowa. At the Massachusetts State Station rowen equaled peas and oats, but the cost of milk production on rowen was higher than on green vetch and oats or on green fodder corn. In Michigan clover silage was relished and kept well, but nothing is added to the feeding value of clover by ensiling it. In Wisconsin 1 ton of clover hay was found equal to 3 tons of corn stalks.

Corn furnishes the most important roughage for dairy cows and more experiments have been made with it than with any other crop for this purpose. Most silage is made from corn. It is usually desirable to feed some hay along with corn silage. In Canada corn silage fed in quantities up to 60 pounds per day made butter equal to that from mixed coarse fodder. It is recommended, however, that not more than 50 pounds of silage be fed per day to each cow. A larger percentage of fat was recovered in setting milk from cows on Robertson's mixture than from those on corn silage.

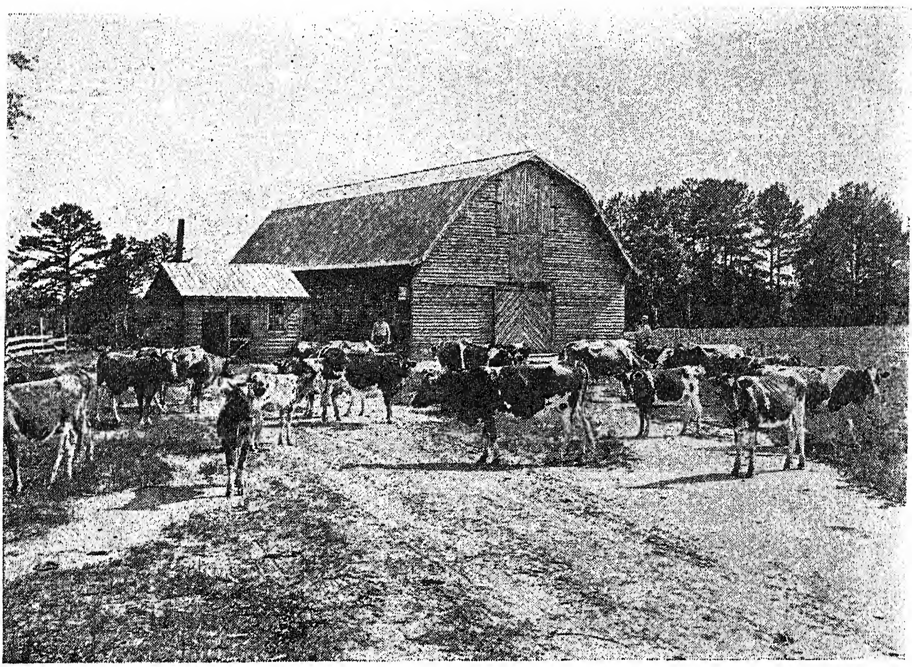
In Vermont corn fodder (stalks and ears) and silage proved about equal, the silage being slightly better on the whole. Both were better than corn stover (stalks without ears). Green sweet corn fodder was better relished than dent corn and gave a better yield of milk. Dent corn produced more forage per acre, however, and was more economical. The butts of corn stover were found equal to the tops, and stover equal to timothy hay. Silage proved better than hay in one test at the same station and inferior in another. Silage from frosted corn was found inferior to that from unfrosted corn. In some cases corn silage made more milk but of a poorer quality than that from corn fodder. Silage appeared to be superior to green corn fodder. Whole silage, stover silage, corn fodder and stover were all relished by cows, and the quality of the milk was the same from all 4 forms of the corn crop. About 3 per cent more milk was obtained from whole silage than from stover silage, and a similar difference was noted between fodder and stover.



MILKING STABLE IN VERMONT

For milk production it was found that 1 acre of corn made into whole silage equaled 1.26 acres of stover or stover silage and 1.08 acres of corn fodder. Whole silage and stover silage were better relished than corn fodder or stover, and the relative cost of preparing and feeding the 4 forms of the crop was greatly in favor of whole silage ("ears and all").

At the New York State Station corn silage caused an increase in yield of milk of 35 to 40 pounds in addition to hay. It was found that a too exclusive ration of corn silage badly affected the general condition of the cows. The Minnesota Station recommends dent corn for silage. Dent, sweet and flint corn were found about equal, dent being slightly in the lead. In New Hampshire a change from dry corn fodder to silage increased the quantity of the milk and the fat content. Silage was found to produce a softer but-



MIXED DAIRY HERD IN SOUTH CAROLINA

and butter and economy of production. In Iowa corn fodder made more butter and at less cost than roots, but silage made a poorer showing than corn fodder. Sweet corn proved inferior to peas and oats, red clover, soy beans or cowpeas as a soiling crop, but the butter from sweet corn scored higher than that from any other soiling crop. In Michigan silage was found more economical than corn fodder and superior to roots.

According to experiments at the Maryland Station there is least loss in feeding corn fodder, shredded, mixed with the grain ration and wet. In Massachusetts corn stover or silage produced milk more cheaply than hay. Fodder, stover or silage was more effective than hay. Silage gave the best results when fed in rations ter than hay, but of better flavor, and was far more effective than hay. In one test in Missouri corn fodder was found superior to silage.

In New Jersey the cows showed no preference between green and dry corn fodder and silage. Silage, however, was decidedly more effective than fodder or roots, both in milk yield and in maintaining the weight of the cows. In one test at the same station the cost of harvesting, storing and feeding dry fodder was less than that of silage. In Pennsylvania it was found that dent corn, cut when the kernels were mostly dented, and the leaves and husks were mostly green, made more butter fat than an equal amount cut earlier or later. The yield per acre is a little less when cut early. Corn fodder

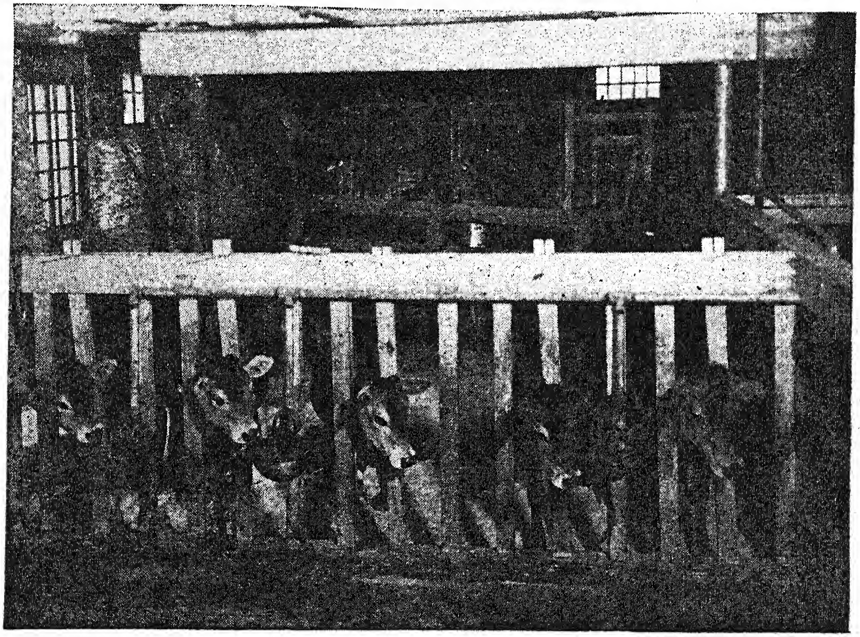
and silage proved equal in every respect in milk production in Ohio and Pennsylvania. The Ohio Station recommends that silage should be made before the corn is fully mature.

At the Wisconsin Station it was shown by experiments extending over several years that silage is somewhat more effective in milk production than dry corn fodder. Cows sometimes ate more silage than fodder. The milk flow was generally greater on silage and the milk was sometimes richer, sometimes thinner. Silage and fodder proved equally digestible. Silage is considered the most economical way of handling the corn crop for dairy cows. Smutty corn proved fatal in Wisconsin, while in Michigan it was fed with impunity. Corn fodder allowed to stand in the field is not so effective as when cut.

Cowpea. This is a very important crop as pasture or silage for cows, especially in the Southern States. In Mississippi cowpea hay proved equal to Johnson grass hay. In Nebraska cowpea pasture made a large yield of milk and butter. At the Delaware Station cowpea silage proved almost equal to the best June pasture. A ration of 25 pounds of the silage and 6 pounds of hay was found excellent for winter feeding. The silage proved slightly superior to wheat bran for milk production and the quality of the butter was equal to that from bran.

The Flat Pea (*Lathyrus sylvestris*) was not relished by cows at the Michigan Station, either as a soiling crop or as silage. The cows lost weight on it and the milk flow decreased.

As shown at the New Jersey Station, "in the feeding of grass silage, whether legume, true grass or cereal crop, it should be remembered that cows are creatures of habit and must be tempered to this new feed. Grass silage of good quality is an excellent roughage for dairy cattle. The best natural source of vitamin A of any preserved fodder at the present time, it holds the key to the economical production of quality milk with consumer appeal."



WAITING FOR BREAKFAST

Hay enters into all rations for dairy cows except when they are on pasture or soiling crops. Hay in the Northern and Eastern States is usually made of timothy and clover. At the Maine Station, when a change was made from a ration of 13 pounds of hay and 25 pounds of corn silage with grain to 8 pounds of hay with the rest of the ration unchanged, a smaller milk yield, loss of weight and unthrifty condition was observed. A change

from hay to silage caused an increased production of milk. The opposite change in New Hampshire produced the opposite effect. In Massachusetts salt marsh hay was found somewhat less effective for milk production than ordinary hay. When fed after milking no flavor was given to the milk. The percentage of milk fat was somewhat less than on ordinary hay. Marsh hay, however, is so much cheaper than ordinary hay that a most economical and effective ration may be made of 12 pounds of salt marsh hay and 1 bushel of silage per day. In Sweden it was found that marsh hay silage, fed in rations not to exceed 20 pounds per day, was about equal to beets.

Kafir Corn fodder or silage is relished by cows and has been found to be nearly equal to corn.

Lespedeza hay in Mississippi was found to be superior to either timothy or Bermuda grass hay.

Millet silage was much relished by cows in Michigan and had a good influence on the milk flow. In North Carolina, however, millet hay, added to a ration of corn silage and grain, had no apparent effect on the yield of milk. Hungarian silage was greedily eaten at the Vermont Station and was equal to hay but inferior to corn silage.

Oats and Peas, green or as silage, are usually combined. Oats and peas at the Toronto Station yielded more per acre than oats and vetch, but the two combinations were equally effective as milk producers. In Vermont oat and pea hay was not much relished, but when eaten gave better results than any other coarse fodder. Oat, pea and vetch silage was apparently superior to corn silage. In Nebraska oats and peas made the best medium early pasture for milch cows. At the Storrs Station they proved to be the best forage crop for midsummer. Oat and pea silage is highly recommended by the Michigan Station. In New Hampshire oat hay alone proved inferior to timothy and clover in milk production. At the Maine Station pea, sunflower and corn silage was found superior to corn silage. This mixture cannot be used to replace all the grain ration, but 20 pounds of the mixture may be substituted for 3 pounds of the grain. Pea silage is recommended in Minnesota and Tennessee.

Rape is a promising silage for dairy cows. As a rule it produces a good flow of milk, but must be fed with some caution, since it may taint the milk. In Canada 55 pounds of rape per day made slightly more milk than corn silage and the milk tested a little higher. The milk had a rape flavor, however, and cheese made from it was gassy. In Iowa the yield of milk and butter decreased when cows were taken from pasture and fed rape as a soiling crop. The butter was of poor quality. In Michigan rape silage was greedily eaten by cows and no taint was imparted to the milk.

Robertson's Mixture Silage is highly recommended in Canada, and has been tested in this country, especially at the Vermont and Maine Stations. In one test it proved equal, and in another decidedly superior to corn silage. Robertson's mixture and corn silage together were found equal to beets and carrots for the production of milk. The mixture may be substituted for a part of the grain ration without loss in weight or milk production. For the preparation of Robertson's mixture *see* under *Sunflowers*.

Rye may be used for pasture, silage or as a soiling crop. In Canada it proved to be inferior to alfalfa in yield per acre, milk production and palatability. In Vermont rye silage was found to be drier, less readily eaten and made 10 per cent less milk and butter than corn silage. In Alabama, however, rye gave better results than silage in milk production. At the Storrs Station it was found the earliest available soiling crop. Rye is recommended for pasture in Nebraska.

Serradella in Massachusetts greatly increased the milk flow when substituted for ¾ of the hay ration. Cows ate from 90 to 97 pounds of green serradella per day.

Sorghum, among other crops tested in Nebraska, furnished the greatest amount of pasture. In Michigan sorghum fodder and silage were readily eaten by cows, but were not equal to corn. Sorghum silage was found to be an economical feed in Tennessee and much superior to cottonseed hulls in Georgia.

Soy Beans ensiled with corn did not materially improve the silage or increase the milk flow over that obtained from corn silage in Vermont. Soy bean-cowpea silage made less but richer milk. The mixed silage was less relished and more expensive to produce. In Nebraska soy bean pasture considerably increased the production of butter fat. In Massachusetts soy beans were found to be superior to peas and oats for soiling. Soy beans and corn silage increased the milk yield over hay.

Timothy is a poor dairy feed, and as a

rule should not be used for that purpose. In Minnesota it was found to be a less economical feed than prairie hay, while in one test it seemed to be superior to silage. At the Storrs Station both timothy and redtop proved to be unprofitable feed for dairy cows, and it is recommended that they be replaced by leguminous hays.

VETCH is considerably used in mixtures for soiling and is valuable for that purpose. In New Hampshire vetch hay proved rather superior to timothy and oat hay.

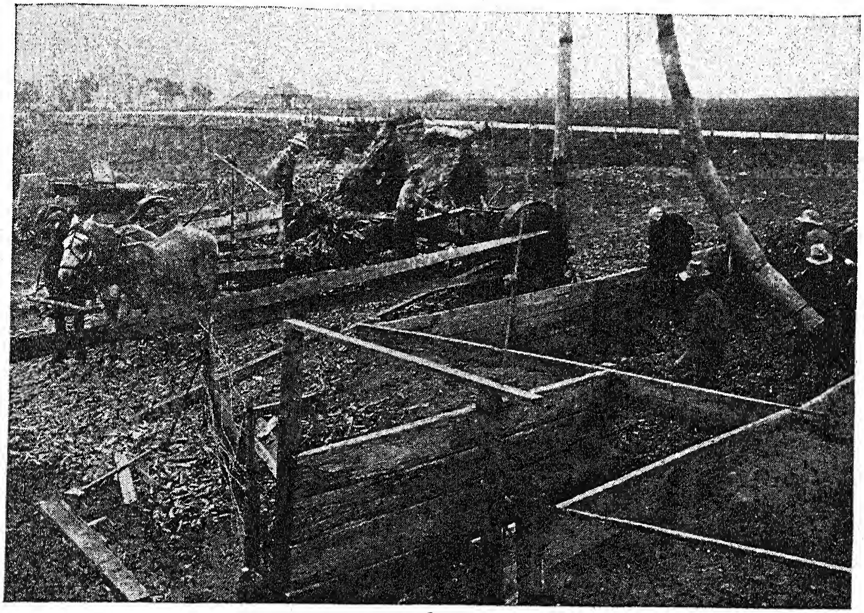
WHEAT at the Storr Station was found to be, next to rye, the earliest available crop for soiling. Wheat is better than rye and can be fed for a longer time.

APPLES, especially windfalls or diseased specimens, are sometimes fed to dairy cows, but they have little feeding value. In Canada apples were unequal to apple pomace for maintaining the milk flow, and the milk was tainted. In Vermont ensiled apple pomace proved equal to corn silage in tests covering a period of 4 years. No care was required in ensiling the material. Apple pomace was fed in rations of 15 pounds with good results.

ARTICHOKES, in a test at the Vermont Station, showed a feeding value about equal to corn silage.

BEETS. In experiments at the Ohio Station field beets made more milk than corn silage, but did not sustain the weight of the cows so well. In other tests beets seemed slightly superior to silage. They increased the consumption of other feeds. As result of all experiments it was concluded that field beets are about equal to corn silage, but more expensive to produce.

CABBAGE is greedily eaten by cows in Iowa and increases the yield of milk and butter. The butter from cabbage does not keep well.



TRENCH SILO IN SOUTH DAKOTA

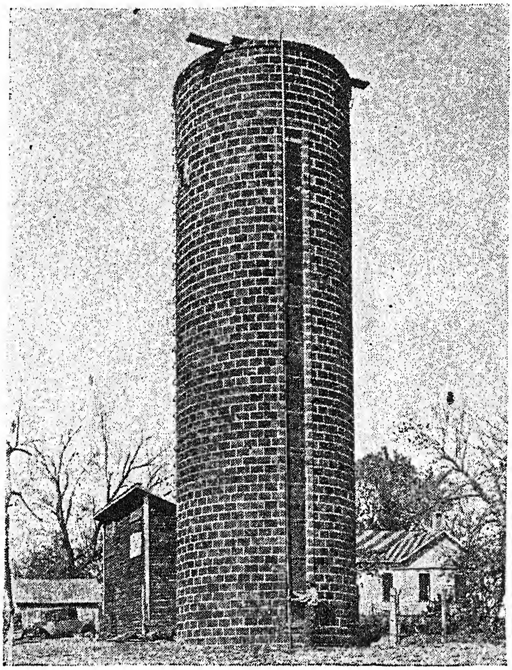
CARROTS, when used in Massachusetts to replace a part of the hay ration, increased the milk yield more than corn silage. In Ohio it was found "carrots make an excellent dairy feed and might be expected to keep the yellow color in milk at a fairly high level during the winter. Often, however, lack of storage facilities makes it impossible to feed carrots during the winter season. Seeking a way to store carrots for winter feeding, Experiment Station dairymen thought of the possibility of ensiling them with some crop which in itself might make silage low in carotene. As a result, field carrots were ensiled with overmature corn having a high percentage of dry matter and bleached leaves and hence a low carotene content. The carrots were fed

into the cutter at as nearly a uniform rate as possible along with the corn. About 1 ton of carrots and tops was used for each 2.25 tons of corn.

"After 2 months the silo was opened. The silage was in good physical condition, had a pleasant silage odor, and an acidity comparable to that commonly found in corn silage. Contrary to what might be expected, the chopped pieces of carrots still had what appeared to be their original physical condition.

"To determine its feeding value the corn-carrot silage was fed to a group of cows for 40 days and compared with good corn silage fed on an equally dry-matter basis to a comparable group of cows. Both groups received, in addition to silage, alfalfa hay fed according to live weight, and a grain mixture fed at the rate of 1 pound to 3 pounds of milk produced to Jerseys and 1 to 4 pounds of milk to Holsteins. At the end of 40 days the silages were reversed, the corn silage cows were given corn-carrot silage and vice versa. Feeding was continued in this manner for 46 days, the first 6 of which were considered pre-experimental, and the data from 40 days were used. The corn-carrot silage was found to be highly palatable.

"Milk and butter fat production on the two silage rations was practically identical, and since the food intake was carefully controlled, it can be concluded that the corn-carrot silage was equal to the corn silage for milk production. The cows receiving corn silage gained a little more weight than those receiving the corn-carrot silage.



IOWA BRICK SILO

"More carotene, shown by greater depth of yellow color, was found in the butter fat produced when the corn-carrot silage was fed than when the corn silage was fed, and this result was in keeping with chemical analyses of the silages for carotene The corn silage contained 54.3 and 80.4 parts per million of carotene (ovendry basis) during the first and second periods, respectively, and the corn-carrot silage 76.9 and 108.9 parts per million of carotene during comparable periods."

MANGEL WURZELS were found to be equal to sugar beets as milk producers in Canada. In Iowa more milk was obtained from mangel wurzels than from sugar beets red table, beets or turnips. The

fat content of the milk, however, was less than that from turnips. In Massachusetts they proved inferior to corn silage for milk production, while in Michigan they seemed to lessen the digestibility of other parts of the ration.

POTATOES. In experiments at the Vermont Station potatoes were eaten more freely than silage, but were slightly inferior in effectiveness. Butter from potatoes was salvy and did not keep well. It was also shown that potatoes at a higher price than 15 cents a bushel are a more costly feed than silage. The Iowa Station found that high grade butter could not be made from cows eating more than 10 pounds of raw potatoes per day. Butter from potatoes is colorless and lacks keeping qualities. In Michigan potatoes lessened the digestibility of other parts of the ration. According to French experiments, dairy cows may be fed an exclusive ration of potatoes with increase in milk flow but loss in weight. No apparent effect on the quality of the milk or butter was noted from feeding potatoes in Michigan.

In Idaho it appears that when "cellar space is not available for storing cull potatoes for livestock feed, the potatoes may be converted into silage. During the 'early potato deal,' or late summer, a trench silo was dug in the hillside and floored with rough 1-by-12-inch boards and filled with a quantity of cull potatoes chopped with an ordinary corn ensilage cutter. To the chopped potatoes were added 3 per cent by weight of ground barley to furnish the proper medium for lactic acid fermentation and 3 per cent by weight of chopped alfalfa hay, the purpose of which was to absorb the excess juice from the potatoes. While the hay was added to the potatoes in a proportion which would seem proper to make the product of the same moisture consistency as corn silage, it was a coincidence that the amount of barley and hay added to the potatoes were approximately the same. There was no run-off from the silo and the moisture determination of the silage showed that it contained 40 per cent of dry matter, approximately 10 per cent more than corn silage. The advisability of adding a large percentage of chopped hay or other dry material to potatoes in a trench silo may therefore be questionable."

PUMPKINS. At the Vermont Station pumpkins, as compared with silage, made from 1 to 2 per cent less milk and butter. It appeared that 2½ tons of pumpkins were equal to 1 ton of silage. The quality of the milk was not affected and the cows were not harmed by feeding pumpkins. In Germany pumpkins made less milk but more butter fat than mangels.

SUGAR BEETS proved equal to mangels as milk producers in Canada, but inferior in Iowa. It was found that the highest grade of butter could not be made from cows eating 20 pounds of sugar beets per day. The butter was of good color, hower, and kept well.

In Massachusetts sugar beets, used to replace part of the hay ration, increased the milk flow more than corn silage. In Oregon they proved equal to carrots and superior to mangels in the flavor imparted to the butter. At the Cornell Station sugar beet pulp was fed in rations of 50 to 100 pounds per day. It was found that partly dried pulp was equal in feeding value to corn silage. As it comes from the factory, however, its value for milk production is about ½ that of silage. In Denmark it was found that butter from sugar beet pulp was equal to that from mangels and that 12 pounds of pulp equaled 1 pound of mixed barley and oats. In Colorado sugar beet pulp showed a feeding value of $2.61 per ton and sugar beets $5.06 per ton in milk production.

TURNIPS. At the Toronto Station turnips, at the rate of ½ bushel per day, gave no flavor to the milk whether fed before or after milking. When 1 bushel per day was fed a turnipy odor appeared in the milk upon heating to 110° F. The odor was more pronounced when the turnips were fed before milking. The turnipy flavor was removed by pasteurizing the milk. Turnip tops were fed with good results in milk yield. In Iowa more milk, but of poorer quality, was obtained from turnips than from mangels. In Norway turnips to the amount of 2.8 bushels per day gave no taint to the milk.

Silage is the term commonly used to designate green forage preserved in airtight structures known as silos. About 38 million tons of silage are prepared annually of which 33 million tons are corn silage and the rest of sorghum, legumes, grass, roots and other forage.

Silage was first prepared in the United States in 1875 by Manly Miles of Michigan. It is now extensively used throughout the country, especially in the Northern dairy sections, as a succulent food for cattle and sheep and to a lesser extent for other animals. The advantages claimed for silos are briefly as follows: (1) Succulent palatable rations may be

had for stock during the entire year, thus keeping the animals in good physical condition and maintain the milk flow of dairy cows and breeding ewes. (2) A larger percentage of the food harvested can be preserved by ensiling than by curing as hay or fodder. (3) Three or more times the quantity of food can be preserved in the same space. (4) It costs less to preserve forage in the silo than to cure it by any other method now known. (5) More stock can be kept on the same area of land where silage is made than where the crops are all cured in hay or fodder. (6) Silage can be made in catchy weather when hay would be spoiled. (7) Crops unfit for hay making or cured fodder, such as weeds, sunflowers, horse beans, etc., can be changed into palatable fodder by preserving in the silo. This may be an advantage when the regular crops fail.

CROPS FOR SILAGE. All crops used for forage may be preserved as silage. The crops usually grown for silage are corn, clover, millet, the small grains, peas, sorghum, alfalfa, cowpeas, soy beans, etc. Corn is the chief crop grown for silage. It is the kind usually understood when silage is mentioned.

CORN. Experiments at a number of stations indicate that corn for silage should not be broadcast but sown either in drills about 3½ feet apart and the kernels dropped 6 to 9 inches distant in the row, or in hills 3½ feet apart each way, placing 4 or 5 kernels in each hill. The crop is richest in feeding value if cut and put into the silo when the kernels begin to glaze or when denting is well established. It is usual to cut the corn and draw directly to the silo. Better results in feeding have been obtained at the Wisconsin and Vermont Stations by ensiling and feeding the grain with the stalks than by harvesting and feeding the grain separately. Other experiments show that it is more economical to ensile corn, ears and all, than to ensile only the stalks and husk out the corn.

Corn packs better, keeps better, is more easily handled, and is more nearly all consumed if it is cut up into small lengths before putting in the silo. About half-inch lengths are preferable and recent work appears to show that better silage will be obtained if the stalks are shredded as well. Corn can be ensiled whole, but the labor of handling makes it an unsatisfactory method of preserving corn. If the whole stalks are put into the silo they should be closely packed in layers. The corners should be packed with stalks bent to fit them. In filling the silo with cut corn great care should be taken to have the corners and the silage along the walls well tramped, not only while the silo is being filled, but every 2 or 3 days thereafter for 8 or 10 days.

The silo may be filled as rapidly as the corn can be cut, or the filling may extend over quite a long period without affecting the quality of the silage. Two or 3 feet of silage may be put in one day and this allowed to heat and settle a day or two, and 2 or 3 feet more put in. When the silo is full the top may be thoroughly wet down with about a 10-quart pailful of water to each square foot of surface. This causes a few inches of the top to rot thoroughly and form a kind of covering impervious to air which protects the silage underneath. No other covering or weighting is necessary. If the water is not put on about 8 or 9 inches of the top will rot.

Corn loses in feeding value when put in the silo but not so much as when cured outdoors. The average loss in 4 years at the Wisconsin Station, when corn was ensiled, was 15.6 per cent of the protein in the corn. Corn fodder, cured according to the usual methods, lost during the same period 23.8 per cent dry matter and 24.3 per cent protein. Considerably larger losses are reported by fodder cured outdoors by a number of other stations. The necessary losses in a well-conducted silo are considerably less than those noted above. Recent work at the Wisconsin Station shows that they need not exceed 4 to 8 per cent of dry matter.

Relative to varieties of corn most suited for silage in any locality, those surest to mature before frost should be chosen. On the northern border of the corn belt the flint corns and some of the earliest dents should be grown. Farther south the varieties producing the largest amount of food per acre.

CLOVER. Common red clover is the kind usually put into the silo, though crimson clover has been recommended by the New Jersey Station, and Mammoth clover is often used. Clover silage is greatly relished by horses, cattle and sheep and pound for pound is richer than corn silage. It does not produce as much food per acre, however, as corn. Clover may be put into the silo whole, but it packs much better and is more easily handled if run through the cutter and cut into half-inch lengths. If clover is put into the silo without cutting considerable cut corn silage should be run on top of it to weight it down. Even more care

should be taken to tramp the corners and sides of the silo than with corn. It is in the corners that the greatest losses occur in ensiling unless they are packed so tightly as to exclude all air.

Clover should be cut for silage when in full bloom and when the dew is off. It should be drawn directly to the silo before it wilts. As a result of 2 years' tests at the Michigan Station, Smith found that while ensiled clover kept well and was greatly relished by stock, it was cheaper to cure it for hay than put it in the silo. It is no doubt true, however, that a good crop of clover could be secured for the silo when catchy weather would make hay making impossible. It must also be remembered that when clover is put in the silo all the leaves and more tender parts are preserved, while in field curing 25 and often 50 per cent of this most valuable portion of the plant is dried up, broken off and lost.

MISCELLANEOUS. Sorghum has been ensiled at some of the stations but is not so satisfactory as corn. In some localities it yields heavier than corn and remains green later in the fall. It is not so greedily eaten by stock as corn silage. Sorghum silage is made in the same manner as corn silage.

Good results have been reported in the use of millet as silage by the Michigan Station. Alfalfa takes the place of clover as a silage crop in the West and is ensiled in the same manner as clover. Cowpeas constitute the chief leguminous forage crop of the South for silage. Robertson's silage, consisting of a mixture of corn, sunflower heads and horse beans, in the proportion of 1 acre corn, ½ acre horse beans and ¼ acre sunflowers, has given satisfaction in some Canadian feeding experiments and reported on favorably by some stations in the United States. Beet pulp obtained as a by-product of sugar beet factories can be readily preserved by packing it in the silo.

Fermentation of Silage. When green forage is first put into the silo it undergoes a more or less rapid fermentation and consequent rise in temperature. It has been commonly supposed that this fermentation was due to the action of bacteria, but recent experiments at the Wisconsin Station indicate that the normal changes in silage are due to physiological processes in the living plant cells themselves and not to bacteria. Bacteria and molds function only in a detrimental way when air finds access to the silage.

Use of Silage. Good silage is fully equal to roots in feeding value and is much cheaper. Feeding may commence as soon as the silo is filled. From 2 to 3 inches of the silage should be fed from the surface each day in order to prevent losses from spoiling. A desirable feature about silage is that it may stay in the silo 2 or more years without loss in feeding value. Many extravagant claims were made for the feeding value of silage when it first came into use. Station experiments show that silage has no greater feeding value than cured forage from which it is made. Experience does show, however, that it is usually the cheapest method for putting up forage and it furnishes a succulent and very palatable ration for stock at a time when such foods are most needed.

Silage is pre-eminently adapted for dairy cows. It promotes and maintains the milk flow and if fed just after milking does not taint the milk. The silo is more in favor with dairymen than with any other class of farmers. From 30 to 35 pounds of silage per day, along with hay and grain, is considered the most satisfactory ration for dairy cows.

Beef cattle have not been so extensively fed as dairy cows, but a number of experiments are reported on this subject. (*See* under *Beef Cattle.*) The Kansas Station points out in this connection that silage should not be fed to breeding bulls. At that station bulls fed on silage seemed to lose their virility and became slow and uncertain breeders. They recovered when again fed on dry fodder.

Sheep do well on silage. About 4 pounds of silage is considered equal to 1 pound of good hay for sheep. Clover silage proved especially valuable for breeding ewes at the Wisconsin Station. Silage should not constitute the sole ration but be fed with grain and hay. About 2 pounds per day per head is sufficient for sheep and in no case should it exceed 5 or 6 pounds. (For experiments with silage for sheep *see* under *Sheep.*)

A number of attempts have been made to feed silage to hogs but without success. They do not appear to relish it or thrive on it. (*See Swine.*)

Silage has been found a good feed for horses when fed not to exceed 20 pounds per day. It should be fed in small amounts at first and preferably with cut hay.

Pasture, Soiling and Silage Compared. After this consideration of the relative value and advantages of pasture,

soiling and silage, it may be well to supplement what was previously said on silage by calling attention to some points in which it possesses advantages over any other system for obtaining succulent feed for dairy cows. The pasture will carry more stock during the spring than at any other season and it may well be helped out, even in the spring season, by some green forage or silage which remains from the winter supply It requires, however, a great deal of labor to cut green crops daily and haul them to the cows, and a still greater disadvantage attaches to a soiling system as compared with the use of silage, in that, in a soiling system, it is necessary to feed the crops during a period of several days, thereby harvesting a part of each crop before it is mature; considerable loss is therefore suffered in the nutritive value of the crop.

For silage, however, the whole crop may be cut at the stage of growth when the greatest amount of material and nutriment is obtained and considerable saving in the case of handling is also secured. With nearly all crops there is an increase in the amount of nutriment up to a certain stage, after which a gradual decrease takes place. Obviously, therefore, the greatest feeding value may be secured by cutting the crop for silage at the right stage of growth.

Occasionally silage is less palatable to cows than green forage or pasture. Now and then an animal will almost absolutely refuse to eat silage. As a rule, however, cows eat it very greedily. For example, in South Dakota, a comparison of different coarse fodders showed that silage was more palatable to cows than either alfalfa or brome grass hay, and butter was produced more cheaply when cows were fed all the silage they would eat than when alfalfa or brome grass hay constituted a considerable part of the ration.

As a rule, silage is decidedly superior to roots in the economy of milk production, but where sugar beets can be grown successfully, the difference in the effectiveness of these two feeds is very little. Thus, in Nebraska, Haecker found that while corn silage gave slightly better results than sugar beets in milk production, the difference was so small that they may be considered practically equal.

Silo, a structure for the preservation of green fodder. (*See Silage.*) The first silos were simply pits dug in the ground. These were filled with green forage, then heavily weighted and covered over with earth to keep out the air. They preserved the silage fairly well but were very inconvenient. Since about 1875 silos of stone, brick, concrete staves, concrete blocks, tile and wood have come into use. Those built of wood are least durable but the first cost is considerably less than where brick, stone or cement is used, and they are equally efficient in preserving the silage.

The essentials of a good silo are that it be air tight, cheap, simple of construction and durable. Some of the principles to be observed in its construction are: (1) That it be made deep in order that the silage may pack down solidly together and exclude the air. Wherever possible it should have a depth of not less than 24 feet. The better silos are usually built 30 feet deep. Very satisfactory silos, however, may be built with depths of only 20 feet or even less. (2) The walls should be vertical and perfectly smooth so that the silage may settle evenly on all sides. There should be as few corners as possible, since the greatest losses from spoilage occurs in corners. (3) Square wooden silos should have the corners boarded across, and the inside sheathing should run perpendicular to the bottom. (4) The inside walls of stone, brick or cement silos should have a final dressing of Portland cement. (5) The silo should be located where it will be most convenient to feed from.

The size of the silo to build may be determined in any particular case from the following data: A cubic foot of well-packed silage will weigh on the average between 35 and 40 pounds, and this is about the amount that should be fed to a dairy cow weighing 1000 pounds. If it is necessary to feed cows for 6 months, or 180 days, during the winter 1 cow will consume 180 cubic feet, or about 3½ tons of silage. A herd of 20 cows would consume 70 tons during the same period. Since, however, there is always some spoiled silage and waste, a safer estimate for the requirements of a herd of this size would be 80 to 90 tons. An acre of good clover or corn will yield 10 to 15 tons of silage.

Another factor that must be considered in feeding out silage, is the depth of silage removed each day. Experience has shown that after feeding from the silo has begun a depth of about 2 inches in winter and 3 inches in summer should be removed from the whole surface exposed each day to prevent loss from spoiling. One cow, therefore, requires a surface area of silage each day of about 5 square feet, and a herd of 20 cows 100 square

feet. This would call for a silo 10 feet square or a round silo more than 11 feet in diameter. The number of tons of silage that a square or rectangular silo will hold may be determined roughly by multiplying together the length, width and depth of the silo in feet and dividing by 50, the approximate number of cubic feet in a ton of silage.

Silos should be constructed with a capacity of ⅓ to ½ greater than indicated by these calculations to allow for settling and waste. A silo rapidly filled and not refilled again will settle nearly one-half.

Fifty years ago the silo was something of a novelty. Today there are over 505,000 in use on farms. Built of brick, concrete, tile, metal or wood, they stand out conspicuously like baronial towers on the farm landscape. When on long train trips across the country I have often found it possible to take a rapid car-window census of silos in different counties of various States, showing pretty accurately the percentage of farms provided with silos. Their condition of repair also indicates something of the enterprise of the farmer. Space does not permit a detailed account of the kinds of silos or the elaborate itemization of plans for silos and steps in their construction. These will vary in different localities and for different farm layouts. Fortunately most of the Agricultural Colleges can supply plans for the kind of silo best suited to local conditions, and many of the State Experiment Stations have bulletins on silos. Your County Agent can help you get such information.

There are a few considerations, however, which apply in general to any kind of silo in any locality. In the first place it will probably not pay to build a silo for less than a 10-cow dairy. The farmer might well hesitate to make the venture with fewer than 20 cows. J. R. McCalmont has recently estimated the cost of permanent silos per ton of stored silage as ranging from $7 to $12 per ton capacity for 25 to 50 ton silos, to $4 to $7 for 150 to 200 ton silos. This would figure out at about $350 for a 50 ton silo and $600 for a 150-ton silo. It is well to remember also that "suffocating gas from fermenting silage, mostly carbon dioxide, forms in all silos shortly after filling begins and continues until fermentation stops. Gas is a particular hazzard in a below-ground silo. During the filling period the blower on the silage cutter should be run several minutes before anyone enters the silo."

Pit and trench silos are especially adapted to semiarid regions and have the advantage of cheapness and ease of construction. In a season of surplus production silage can thus be stored for use during a future year of drouth and scarcity. Cases are on record in Australia where fodder thus preserved has been found in good condition 15 years later Even prickly-pear cactus may be utilized by this method, since the spines are softened during the process of fermentation.

Some materials, for example the vines and pods from pea-hulling plants, pack down so solidly of their own weight as to require no covering. The whole mass turns into silage with only a few inches of spoilage on the exterior of the pile. For emergencies woven-wire fencing, snow fences, bundles of corn fodder, or bales of straw may serve as walls for temporary silos and bound together with wire bands. Such walls may be made quite air tight with special paper or other materials. The only essential point in any silo is that the air be excluded, while the silage is undergoing the proper fermentation.

Miscellaneous Feeds, Salt and Water. Brief notes may be given on these subjects in the following paragraphs:

CANE SUGAR added to the ration of dairy cows had little effect on the quantity of milk and none on the quality as tested at the Vermont Station.

CONDIMENTAL FEEDS have been tested at Connecticut, Maine and Massachusetts Stations and elsewhere. They have nearly all been shown to be valueless. The claims made for such feeds are absurd and the prices extravagant.

BONE MEAL was tested at the Vermont Station. When added to rations of dairy cows it had little effect on the ash content of the milk, but increased the quantity of phosphoric acid.

SKIMMILK may be profitably fed to dairy cows. It has a favorable effect upon the churnability and quality of butter fat. In Sweden clabbered skimmilk was found of little value for that purpose.

OILS have been fed to cows to determine whether the yield of milk and butter might be thus increased. In Vermont it was found that unemulsified cottonseed oil, when added to the ration, increased the milk yield 3 per cent and the total solid content 5 to 10 per cent. Emulsified oil increased the milk yield 4 to 9 per cent and the total solid content 2 to 15 per cent. Emulsified corn oil and linseed oil had similar effects. In Maine it was found that an increase of food fat caused an increase of milk fat. According to

investigations in Massachusetts, New Hampshire, Denmark and Sweden, cottonseed oil, corn oil, palm oil, cocoanut oil, oleo oil and stearin temporarily increased the fat in milk. With the continuance of such feeds, however, the milk soon returns to the normal composition. At the Cornell Station tallow fed for 10 days in rations of 2 pounds did not increase the milk fat. Heavy feeds of oil derange the digestion and the butter may be so affected as to be virtually adulterated. Since the effect of oils is only temporary there is no economy in feeding them. (*See* also *Rations* below.)

SALT is a necessity with dairy cows as with other animals. A supply of salt should be constantly accessible to the cows. It may be furnished granulated or in large pieces of rock salt. In Canada, when salt was withheld from the cows, the average loss in the milk yield was 14.5 per cent. Similar results were obtained at the Mississippi Station.

WATER. An abundant supply of fresh, pure water should be always accessible to milch cows. Cows may be expected to drink from 60 to 120 pounds of water per day, according to the ration. At the Vermont Station cows allowed to drink at will gave 2 per cent more milk than when watered at intervals. Several stations have tested the value of warming the drinking water for cows. As a rule no advantage has been found in this operation, the results being in some cases in favor of warm water, in others in favor of cold water.

The Oregon Station reminds us that "Water is very essential in the cows' ration, inasmuch as her body on the average contains about 55 per cent of water. Also milk contains 87 per cent water. Water is essential for the proper digestion of feeds and is the largest constituent of blood and lymph that carry nutrients to all parts of the body. Water assists in the elimination of waste products in the urine and feces. The body temperature is controlled by evaporation of water from the skin and through the lungs. The amount of water required by the dairy cow depends on the amount of milk she is producing, her body weight, the type of ration fed, and the temperature of the air.

"As water is the cheapest ingredient that a cow requires for milk production, she should be provided with an adequate amount. Under moderate temperature conditions, the cow requires about 6 pounds of total water daily per 100 pounds of body weight, and about 1½ pounds of water for each pound of milk produced A 1000-pound cow producing 40 pounds of milk daily would require a total of 120 pounds of water. The provision of a convenient supply of pure fresh water is necessary for economical production.

"Feeds vary considerably in the amount of water they contain. Concentrates usually contain about 10 per cent water. Hays vary somewhat more, but usually contain a little more than 10 per cent water. In contrast to concentrates and hay, the succulent feeds are high in water. Pasture grasses and clover contain from 75 to 85 per cent, the silages from 65 to 75 per cent, and the root crops from 80 to 90 per cent of water. Naturally the free water requirements of a cow depends to a large extent on the type of ration fed.

"In the example given above the cow requiring 120 pounds of water daily would obtain from 20 to 25 pounds of water in the feed, if the ration consisted of 10 pounds of concentrates, 15 pounds of hay, and 30 pounds of silage, and would require 95 to 100 pounds of free water. In hot weather cows may drink 80 per cent more water than in moderate weather. At freezing temperatures cows will drink about the same amount as in moderate weather if the water is not too cold."

Grains. The best results cannot be obtained from milch cows without feeding grain. Even when cows are on the best pasture, or are fed soiling crops in large rations, the addition of grain increases the milk yield. With cows on good pasture the effect of the grain may not be apparent at first. But as the pasture becomes short the grain rations may be increased and will have more uniformly beneficial effects in cows which are already accustomed to grain feeds. In order to secure the largest total milk yield, the cows should be stimulated to the best possible flow of milk during the early stages of lactation, and this flow should be maintained by judicious grain rations.

As a rule nitrogenous grains are more effective in milk production than corn. The ability of different cows to make profitable use of grain varies greatly. The grain rations may vary in size from 2 to 12 pounds per day, but only the best dairy cows can utilize large grain rations.

At the Vermont Station some cows on rations of 6 to 14 pounds of mixed meal per day gained in quantity and quality of the milk. Especially the milk sugar was increased. Other cows, however, got off feed or showed no change. Cows gave ⅓

more milk and butter fat on full grain rations than without grain. Better results were obtained from heavy than from light grain feeds. Only good cows, however, were able to utilize 8 to 12 pounds of grain per day. Experiments at the Cornell, Kansas, Mississippi and North Dakota Stations indicate that the immediate results from feeding grain to cows on good pasture are not striking, but that the weight of the cow is better maintained on grain, and beneficial results are seen in the flow of the milk late in the season. Similar results were obtained in Utah. The Wisconsin Station found that it did not pay to feed more than 8 pounds of grain per day. A ration of 12 pounds was fed at a loss, and the after effects were bad. At the New Jersey Station 10 pounds per day was found the largest profitable grain ration while in Utah 8 pounds is considered as the outside limit of a grain ration, and feeds of more than 6 pounds increased the cost of the milk.

In Massachusetts, with cottonseed meal, linseed meal and gluten meal at the same price, there was little difference in their economy in milk production. In New Hampshire corn meal, shorts, middlings and cottonseed meal were found of about equal value. In the following paragraphs brief notes are given on the individual grains commonly used for feeding dairy cows.

Barley and Brewers' Grains. In German experiments barley meal proved an effective and desirable dairy feed in every respect. In Minnesota ground barley was found equal to ground wheat or corn meal. At the Maine Station barley and peas made a soft butter. The Geneva Station has shown that malt sprouts or brewers' grains may be substituted for oats or peas for milch cows. In Wisconsin malt sprouts proved inferior to cottonseed meal or corn meal. In Connecticut brewers' grains were fed in rations of 13½ pounds with good results, while in Massachusetts they proved to be a good substitute for wheat bran. In New Jersey 4 pounds wet brewers' grains were found equal to 1 pound dry.

Beans. The common sorts of garden and field beans are seldom fed to milch cows in this country. In Scotland horse beans were found to make a good quality of butter. In Massachusetts soy bean meal made more and richer milk and butter of a better color than cottonseed meal. The cottonseed butter was firmer but inferior in texture.

Buckwheat. In a test at the Vermont Station buckwheat middlings made 4 per cent more milk than corn and bran, and 3 per cent less than cottonseed or linseed meals. The quality of milk was about the same with all feeds. A subsequent test confirmed these results in general, but showed that milk from buckwheat middlings contained more fat than that from any of the other feeds. The middlings made firmer butter than any other grain ration. Buckwheat middlings are not especially relished alone and should be mixed with other feeds. In New Hampshire ground buckwheat proved valuable for milk production.

Corn and Corn By-Products. This grain may perhaps best be fed unhusked. The shock corn, however, is commonly run through a feed cutter before feeding to milch cows. After corn has been husked or shelled for some time it becomes very hard and should be ground before feeding. Corn meal is greatly relished by cows, and this fact often leads to excessive feeding. It should be mixed with bran, shorts, linseed meal, cottonseed meal or other nitrogenous grains for dairy feeding.

In New Jersey corn meal gave 9 per cent more milk than whole corn, and 57 per cent of corn fed in the ear was undigested. In Mississippi corn meal was not economically fed with dry hay. At the Pennsylvania Station cerealine was found equal to dried brewers' grains or buckwheat middlings, and the value of corn meal for milk production proved to be ⅕ greater than bran. According to some experiments in Germany corn was most effective for milk production, followed by wheat bran and cottonseed meal. Gluten meal proved to be an excellent dairy feed in Germany and Vermont. The butter from gluten meal was slightly inferior in grain to that from corn meal and bran, or that from cottonseed meal or linseed meal. In a second test the butter from gluten meal was best. Buffalo gluten meal was found superior to a ration of cottonseed meal and linseed meal. The Maine Station found that gluten meal could be substituted for cottonseed meal, but that it must be fed in larger quantities. The butter was softer than that from cottonseed meal. In Vermont germ feed had about the same feeding value as a mixture of corn meal and bran. Sugar meal and cream gluten meal were more nutritious and influenced the richness of the milk more decidedly. Both cream and king gluten meals were found to have a greater feeding value than a mixture of

corn meal and bran. It has been found at the Maine, Michigan and New Hampshire Stations that all gluten products containing a large percentage of oil softened the butter. At the Geneva Station wet, acid corn slump, dry slump and dried slump acidified with acetic acid were fed to cows without harm. The milk yield was increased but the quality was adversely affected. In Kansas corn meal was found to increase the milk yield more than bran and oats.

COTTONSEED MEAL. This is a very effective dairy feed. It should not be fed as the only grain ration, however, and should not be used extensively until some experience has been had on a small scale. At nearly all the stations where it has been tested, cottonseed meal was found to raise the melting point of the butter. A little cottonseed meal is recommended when firmer butter is desired. In Texas it made a firm but salvy and light-colored butter, while in Iowa the butter scored as high as that from corn meal, and no bad effects were observed from rations of 2 to 6 pounds per day. In Michigan and New Hampshire butter was badly affected when cottonseed meal was fed to excess. It proved slightly better than corn meal for milk production, and in Germany it was superior to linseed meal for this purpose. In Vermont it made more milk, but also cost more than gluten meal. In Alabama in rations of 3 to 5 pounds per day it diminished the quantity but increased the fat content of milk.

Cottonseed meal added to corn meal gave greater returns than corn meal alone at the Maine Station. In Pennsylvania it produced more milk than bran, but the butter from bran was rated higher. The milk yield was increased by it at the Texas Station. In Mississippi 1 pound of cottonseed meal proved equal to 3 pounds of corn and cob meal for milk production. In Texas it was found most economical to feed cottonseed in combination with other grains. Rations of 6 pounds of cottonseed meal were found more economical than 7, 8 or 10 pounds. In Massachusetts this feed was found about equal to good hay for milk production.

LINSEED MEAL is an important feed for milch cows on account of its high protein content and its laxative and regulative action. In Colorado it produced a larger percentage of milk fat than any other grain. In Iowa it was found that either linseed meal or ground flaxseed could be safely fed in rations of 8 pounds per day. Linseed meal and bran, substituted for a part of the corn ration, increased the yield of milk and butter. In Massachusetts the new and old process linseed meal were found to be of equal value. At the Michigan Station linseed meal had no effect upon the butter. In Pennsylvania it proved equal to cottonseed meal, and in Wisconsin it was found slightly better for producing milk fat than either wheat bran or corn meal. New process linseed meal was about equal to corn meal, but made a better butter. In Germany flaxseed had little effect in increasing the milk fat, but disturbed the digestion of the cows.

OATS are fed to dairy cows quite extensively. In Scotland they are considered as producing a good quality of butter. In Vermont oat feed was found equal to a mixture of bran and corn meal in equal parts. Quaker oat feed made 2 or 3 per cent less milk than corn meal and bran, but the quality of the milk was the same. In Maine ground oats proved equal to wheat bran for milk production, while in Wisconsin they were found more effective, but also more expensive.

RYE MEAL was tested at the Pennsylvania Station in a balanced ration. It checked the milk flow somewhat and was inferior to corn meal.

SORGHUM MEAL, when free from hulls, in experiments in New Jersey, had no effect on the health of the cows and did not influence the taste, color or composition of the milk. It made 7 per cent less milk than corn meal.

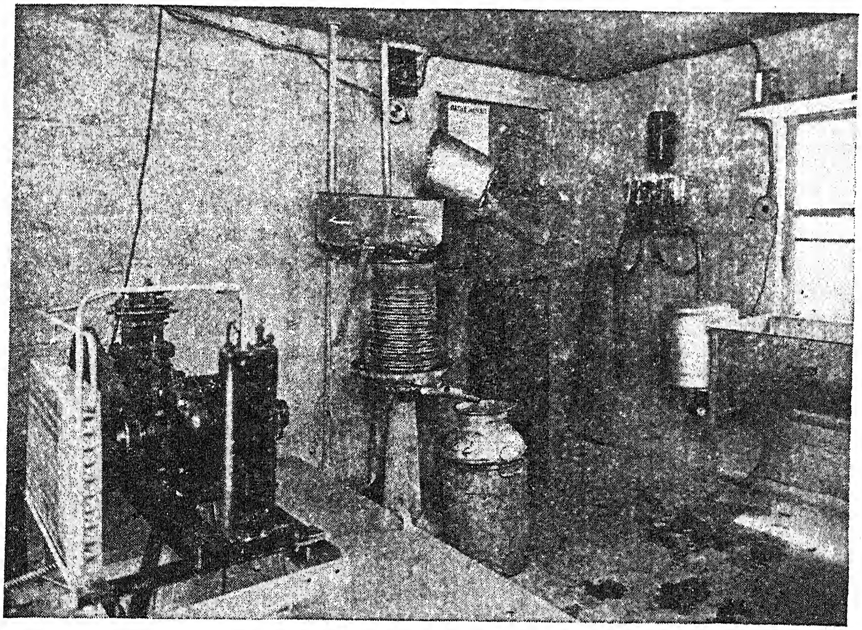
WHEAT. In Canada ground wheat was found to be a wholesome and effective dairy feed, but was not equal to mixed meal. In Vermont wheat bran proved about equal to buckwheat middlings, barley meal, corn meal or cottonseed meal. In Colorado bran gave greater yields of milk than other grain feeds. In Iowa the milk yield was increased by feeding bran to cows at pasture. In Maine wheat meal proved slightly superior to corn meal. In Massachusetts bran was not very effective when added to a silage ration. In Minnesota ground wheat proved equal to ground barley or corn meal. At the North Carolina Station wheat middlings and bran, half and half, were found more effective than bran alone. In Wisconsin roller bran proved equal to corn meal, nearly equal to linseed meal and more economical than either.

Rations. For obtaining the best results from dairy cows it is desirable to keep the bowels in a loose condition. This matter is easily regulated if the effects of

various feeds are kept in mind. The following may be considered loosening feeds: Alfalfa, clover and other legumes, roots, silage, sorghum hay, bran, soy bean meal, linseed meal and gluten meal. The following is a partial list of constipating feeds: Corn fodder, corn stalks, Kafir corn fodder, various grass hays, including timothy, Kafir corn, corn and cottonseed meal. It is also important in dairying to secure a proper firmness in the butter. As a rule corn, Kafir corn and cottonseed meal make hard butter, while linseed meal, soy bean meal and gluten meal have a tendency to soften the butter.

Narrow rations are generally recommended for dairy cows. Narrow rations were found superior to wide rations in experiments at the Hatch, Maine, Massachusetts State, Nebraska, New Hampshire, Pennsylvania, Storrs and Texas Stations. In Vermont no constant differences were noted in the effect of wide and narrow rations, while in New Jersey milk and butter were produced more economically on well-balanced than on irregular rations. The Storrs Station investigated the rations in common use among dairymen in Connecticut and found that the amount of protein could be profitably increased in almost every case. At the Cornell Station a medium ration gave a better yield of milk than a narrow or wide ration. For a discussion of "wide," "narrow" and "balanced" rations *see Feeding Farm Animals.*

Great differences of opinion prevail with regard to the possibility of affecting the amount of fat or other solids in the milk by means of the feed. Experiments along this line have not led to uniform results, but indicate that a specific effect of any feeding stuff on the quality of the milk is either not noticable or of short duration. In Massachusetts the quantity and quality were not affected by a change in the grain ration. The New Hampshire Station found that the "quantity is the result of food influence. Quality is the result of the makeup of the animal." In Maine the milk yield from a highly nitrogenous ration (cottonseed meal and gluten meal) was greater than from corn meal. The total solids in the milk were 30 per cent to 40 per cent greater, but the relative proportion of the different solids varied independently of the feed. It is concluded, therefore, that it is not possible to produce more butter fat without a corresponding increase of the other milk solids. In Canada it was found that the quantity of the milk could be much influenced by the feed (large quantities of succulent or dry fodders) but the quality was largely determined by the individu-



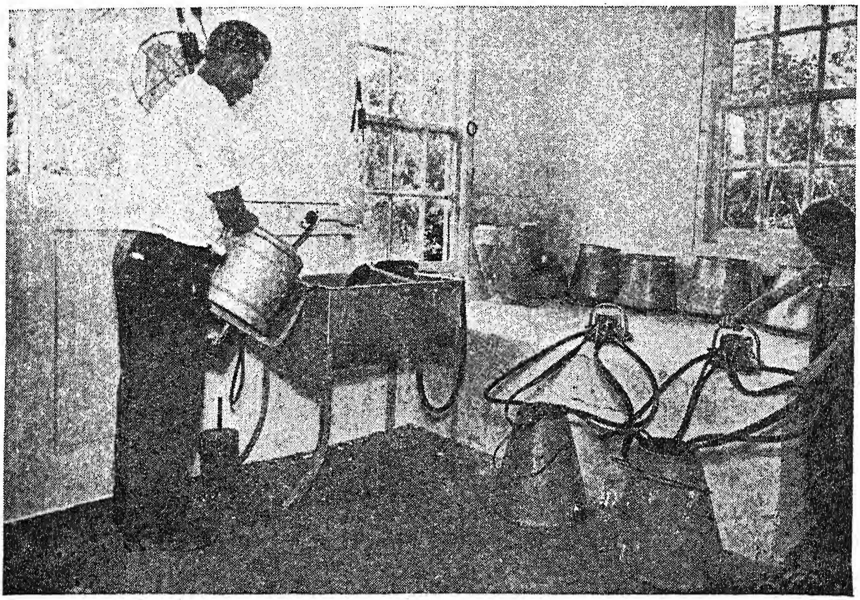
DAIRY FARM MILK HOUSE

ality of the cow. It has also been demonstrated that when there is a lack of fat in the feed the body fat may be changed into milk fat.

The Maryland Station maintains that the productive capacity of average dairy cows may be much increased by proper care and better feeding. It is even asserted that improvement of a herd may be secured more quickly by feeding than by breeding. The capacity of a cow may be permanently improved by good systematic feeding for 1 year. The after effects are observed in larger yields of milk during the next year.

The actual size of the ration will vary greatly according to individual cows. Some cows can successfully utilize much more grain and coarse fodder than others. The usual rations of different feeding stuffs are discussed above under the individual feeds. As an example of a large feeding capacity we may cite the case of a Holstein cow at the Missouri Station which ate as a daily ration 15 pounds bran, 3 pounds linseed meal, 6.65 pounds each of corn meal and ground oats, 42 to 50 pounds of silage and 12 pounds of clover hay. In Pennsylvania it was found that it was not profitable in the case of average cows, to increase the ration as long as the milk yield increased. A limit was soon reached beyond which the extra production was obtained at a loss.

In planning rations for livestock it should always be remembered that animals utilize feed as a steam engine uses fuel. Part of the energy derived from feed or fuel is used up in running the machine. The Oregon Experiment Station has established that a 1000 pound cow in producing 30 pounds of milk per day, when properly fed, uses 45 per cent of her feed for maintaining body temperature, locomotion, digestion, blood circulation and tissue repairs. The remaining 55 per cent of the feed is used in the production of milk. If fed less than required, the cow might use 60 per cent or more of her feed to keep bodily functions operating. If fed more than required, 15 per cent or more of the feed might be used to produce body fat, while milk secretion fell off somewhat.



WASHING MILK UTENSILS

Wet vs. Dry Feeds. The Toronto Station found that wetting bran or grains, or "slopping" was an expensive method of feeding. The wet grain passed almost directly into the 4th stomach and was not well masticated. In Iowa, on the other hand, the results were slightly in favor of a wet feed. In Vermont no constant difference was observed in the value for butter or milk from wet and dry feeds.

DAIRYING.

In dairying, as conducted at present, the farmer is primarily, or almost exclusively, interested in the production of milk. The technical operations by which butter, cheese, condensed milk and other milk products are manufactured, are chiefly of interest to experts in creameries, cheese factories, etc., to which the farmer delivers his milk. It is only in the rarest instances that the farmer makes his own cheese, and the butter which is made on the farm is perhaps 10 per cent of the total butter production. In a large percentage of cases, therefore, after the milk has been produced the farmer is directly interested merely in caring for it until it can be delivered to the factory or the patrons of his milk route in good condition. The present discussion will, hence, be confined to a few details concerned with the care of milk and to a brief general account of butter and cheese making.

Testing Milk. The milk from each cow should be weighed at each milking and a record should be kept so that the productivity of each cow may be known. Unprofitable cows may thus be culled out. From time to time, also, a test should be made of the milk of each cow to determine the percentage of butter fat.

Fermentation of Milk. The rapid fermentation of milk is due to the presence of bacteria or other filth in the milk. If milk is intended for the manufacture of butter or cheese the bacteria simply serve to hasten the ripening process. If the milk is to sold as food, however, it is desirable to keep it sweet as long as possible. Even when every precaution is taken enough bacteria will gain entrance to the milk to produce ripening and souring.

Two hundred or more species of bacteria have been found in milk. The most of them, however, are harmless, except that they cause a rapid souring of the milk. Some produce bitter or otherwise disagreeable flavors, others produce gas, color changes, etc. It should always be remembered, too, that milk may easily become contaminated by the germs of infectious diseases, such as tuberculosis, scarlet fever, diphtheria, typhoid fever, undulant fever, etc. Epidemics of these diseases are often caused by careless milkmen.

Cleanliness. In order to prevent the contamination of milk with bad odors or bacteria the most scrupulous clealiness is required. No dust should be flying about in the stables at milking time. If the cows are allowed to eat at this time the feed should be sprinkled. It is better not to feed them until after milking. The cows should be clean or thoroughly brushed off, the hands and the clothing of the attendants should be clean and no fermenting or decomposing material should be allowed to accumulate in the stables. Careful attention should be given to cleansing and scalding all cans, pails, etc., with which the milk comes in contact. These various precautions have been recommended times without number, but they are by no means universally observed, and as a result the milk sours within a few hours after delivery. Cleanliness applies to milking machines as much as to human milkers. Every part of the machine must be properly cleansed and sterilized after each use. Otherwise the bacterial contamination of the milk may easily become worse than from hand milking. Some large commercial dairies, after struggling with the problem, have returned to hand milking on account of unpleasant experiences with milking machines. The milkers in these cases seemed to be more successful in cleaning their hands than in cleaning the machine and the tubing and other attachments.

Straining, Cooling, Aerating. Immediately after being drawn from the cows the milk should be strained to remove any coarse filth which may have fallen into it. It may then be aerated by pouring back and forth from one vessel to another, or by the use of one of the many devices designed for this purpose. Aeration is practiced for the purpose of removing animal odors from the milk or odors due to various feeding stuffs. Aeration and cooling may be accomplished at the same time. It is desirable to cool milk down as quickly as possible to 40° to 60° F. A temperature of 40° is better than 60°. The bacteria are thereby prevented from multiplying too rapidly and the milk remains sweet much longer. Where a stream of running water is to be had a Star cooler is about as good as any for this purpose.

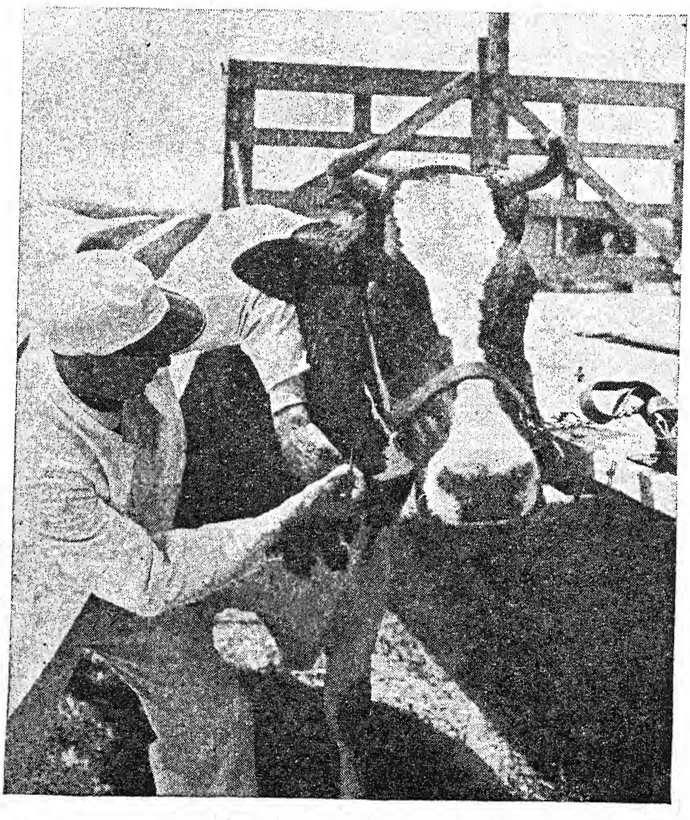
Composition of Milk. Where milk is produced for the manufacture of butter the percentage of butter fat is an important matter. The average percentage composition of milk is about as follows: Water 87 per cent, fat 4 per cent, casein 3.4 per cent, milk sugar 4.9 per cent, and ash .7 per cent. In making butter, fat is the only solid which is removed from the

milk, while in the manufacture of cheese both the casein and fat are removed.

Creaming the Milk. There are three general methods in vogue among farmers for separating the cream from milk, viz.: Setting in shallow pans, setting in deep cans with cooling devices, and the use of separators. The third method is the best, for various reasons which will be mentioned below. It is best to run the milk through the separator, or set it, as soon as possible after milking. There is no great loss in butter fat, however, if these operations are delayed for 3 or 4 hours. Milk should be cooled before setting, otherwise some fat is lost. This matter, however, is less important in the North than in the South. With shallow setting in pans 2 or 3 inches deep the best results cannot be obtained if the milk is allowed to become warmer than 60° F. The milk should be set in a cool, dry, well-ventilated room free from bad odors. The cream should be removed as soon as the milk at the bottom of the pans has thickened.

If the milk is set in deep cans, these should at once be placed in ice water or cold running water. For cooling milk in such cans spring houses are quite satisfactory. The water around the cans should be between 40° and 55° F. At the Cornell Station it was found that 24 hours was a long enough period for shallow setting. Some fat was lost when the pans were skimmed after 12 hours. At a temperature of 70° F. the cream was found to rise faster when the milk was set 3 inches deep than when it was set 6 or 9 inches deep.

The use of a separator is a better method for securing the cream than any setting method. If the separator is used no ice or extensive cooling devices for the milk are required; the bacteria have no time to develop and multiply; more cream is obtained from the same quantity of milk, and the skimmilk may be fed to the calves and pigs in a sweet and wholesome condition. Sweet skimmilk is incomparably better for feeding calves than sour skimmilk.



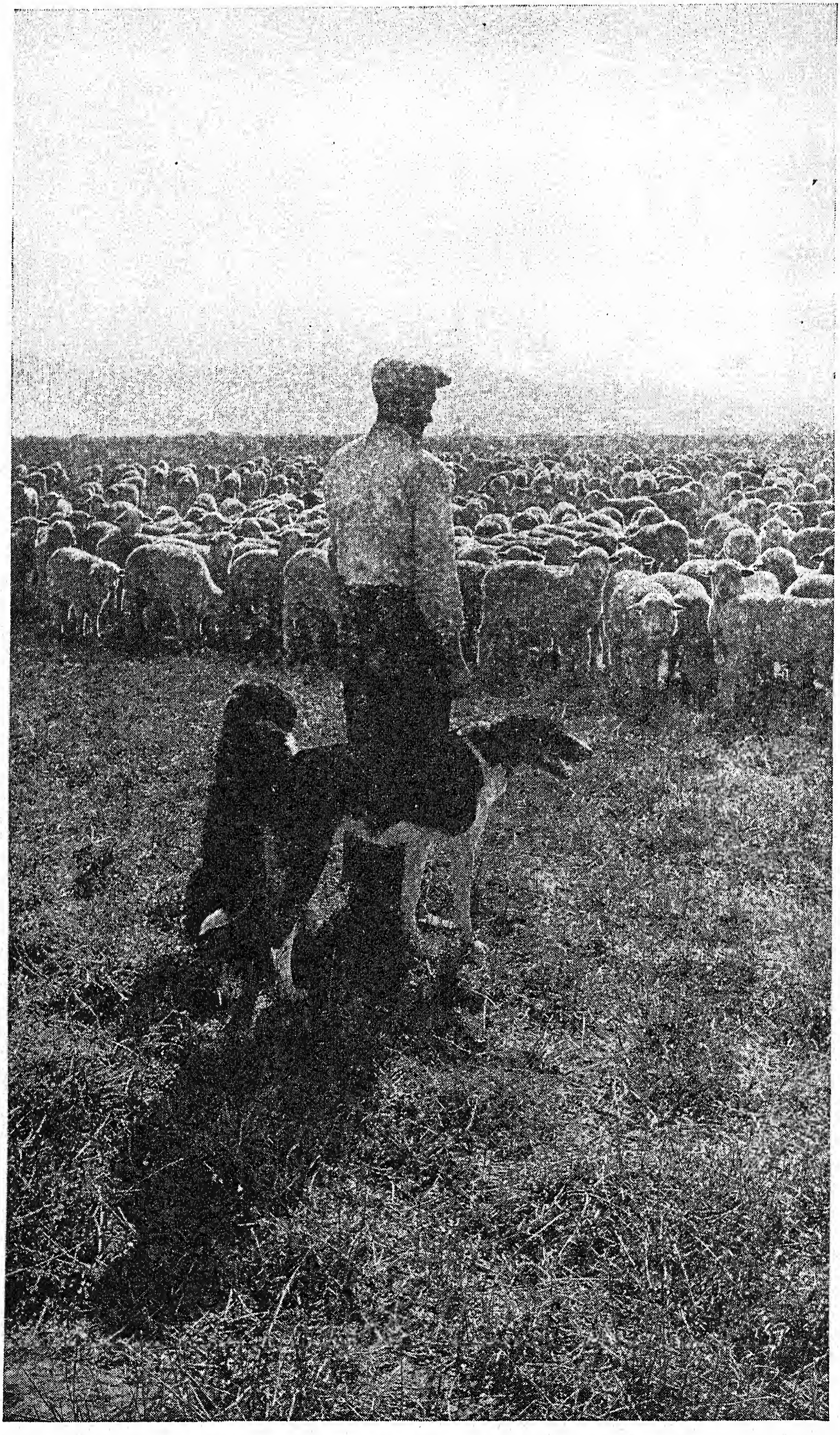
TESTING FOR BANG'S DISEASE

PART V

OTHER LIVE STOCK

Horses, Sheep, Swine

Principles of Feeding, Veterinary Medicines, Etc.



HERDING SHEEP ON THE RANGE

OTHER LIVE STOCK

FEEDING FARM ANIMALS

The chief purpose in feeding farm animals is to produce meat, milk, eggs, wool, etc., or energy in the form of work. Animals in a wild state eat enough to keep themselves alive and maintain their condition. They may take on a moderate amount of fat during the summer which serves to tide them over the winter season when food is scarcer. Man has interfered, however, for the purpose of securing greater production. One of the weighty considerations which has governed breeding experiments with domesticated animals is the idea of producing breeds which can consume large amounts of feed and make good use of it.

One respect in which improved breeds almost uniformly differ from native or unimproved animals, is the greater capacity of the stomach and intestines and the increased ability to give profitable returns from large quantities of feed. The greater digestive capacity, increased fertility and earlier maturity, if not accompanied with loss of vigor, make pure breeds or first crosses more profitable feeders than scrubs.

Rational feeding is based to a large extent upon the sciences of physiology and chemistry. The successful feeding of animals for profit, however, is an art and not a science. This fact is becoming quite generally recognized and there is a growing and laudable tendency to break away from the idea which has long prevailed, that successful feeding must conform to the mathematical formulas contained in the German feeding standards. These standard rations were computed from digestion experiments without reference to the comparative cost or convenience of obtaining the various feeding stuffs.

The chief problems before the practical stock grower are what feeds are most effective in animal production, in what amounts should they be fed for greatest profit, what combinations of feeds are most effective, and what effect have the various feeding stuffs on the quality of the meat, fat, milk, etc. But after these questions have been satisfactorily answered, the ration in any particular case will be compounded from the cheapest available feeding stuffs in suitable proportions. It would obviously be bad economy for a stock grower to haul one grain to market and haul another back, simply because the grain which he raised did not happen to be the one used in some successful feeding experiment. The economy of production of the various grains and coarse fodders will determine in almost every instance the ration adopted for a given purpose.

After an economical and effective ration has been selected, the farmer will of course set about to feed it so as to get the greatest possible returns. As a rule in fattening animals an attempt should be made to put them in condition for market within the shortest possible feeding period. For this purpose the animals should be gradually induced to eat a maximum amount of feed, all that they will eat up clean. Animals are much influenced by the quality and palatability of the feed. The feed stuffs should be clean and should be prepared in an appetizing manner. Attention to these little details may prevent the animals from getting off feed. In order to avoid loss of appetite and consequent checks in the process of fattening, changes in the grains and coarse fodders of the ration should be made from time to time. In such changes substitutions should be made according to the relative feeding value of the different materials. Suitable substitutions are indicated in the discussion of the feeding of each animal. (*See Beef, Cattle, Swine, Sheep, Dairy Farming, Chickens, Ducks,* etc.)

The ration must be adapted to the species of animal. It has been found by practical experience that certain feeding stuffs are injurious to certain kinds of domestic animals. For instance cottonseed, if fed persistently, will kill pigs, calves and chickens. It is a valuable feed, however, for fattening steers and for milch cows. The individuality of different animals of the same species may be quite striking, especially in their choice of feed and in the amount which they can use to good advantage. Different classes of animals also require different rations. In general, the ruminants require and can make good use of a larger quantity of coarse fodders than pigs or horses. These

are matters which must be learned from practical experience and in which little help can be expected from theoretical science.

Composition of Feeds. Different feeding materials contain the important organic chemical compounds in different proportions. Some of these compounds are always mentioned in accounts of feeding experiments and should therefore be briefly defined here.

PROTEIN is a short term used to signify a group of compounds containing nitrogen. Nitrogen constitutes from 15 per cent to 19 per cent of these substances. The group is a very heterogeneous one and the different substances differ so greatly in physical and chemical properties that they have nothing in common except that they contain nitrogen. Protein is present in all animal tissues and is absolutely necessary for repairing the waste in these tissues. Animals could not live for any long period without protein. The minimum quantity which is required, however, has never been determined with any accuracy. While the chief function of protein is to furnish material for building up the muscles, blood and other tissues of the body, it may, under certain conditions, form fat and later furnish heat and energy.

ETHER EXTRACT, as used in works on feeding, includes the various fats and oils in the feeding stuffs, which can be extracted with ether. In general, seeds and grains contain more fat than the coarse fodders, straws less than hays, and roots and tubers but little. Of the cereal grains, corn and oats contain the most oil, but the seeds of flax, cotton, sunflower, rape and mustard are very rich in fat. Peanuts contain a large percentage of oil.

CARBOHYDRATES is a term used to denote the starches, sugars, gums and similar substances in feeding stuffs. Nitrogen-free extract is also sometimes used as synonymous with sugars and starches, but it really includes certain other less important substances. The carbohydrates constitute the greatest portion of the dry substance in feeding stuffs. Starch is the most important member of the carbohydrates and forms the largest part of the dry matter of grains, and of the tubers of potatoes, rootstocks of cassava, etc. Commercial starch is largely obtained from corn, potatoes and cassava. Vegetable gums, some of which are known to chemists as pentosans, are found in considerable quantities in hay, corn fodder, sugar beets, wheat bran, gluten meal, etc. Sugars occur in smaller quantities than starches but their feeding value is greater. Saccharose, the common crystallized sugar of the market occurs in fruits, grasses, sweet potatoes and other roots, but is most abundant in sugar cane, sorghum, sugar beets and corn fodder in a fresh condition. Grape sugar and fruit sugar are also found in various fruits and fodder plants. The carbohydrates, and the fats and oils, when digested in the animal body, furnish heat and energy. Until recently it had been supposed that this was their only function. Recent experiments, however, have shown that a large part of the animal fat may be derived from starch and sugar in the food. This explains the great feeding value of corn meal, which in practice far exceeds that computed from a theoretical standpoint. Experiments show that milk fat may be in large part derived from starch and sugar. The feeding value of fats and oils is much greater than that of starches and sugars. A part of the food fat may be directly modified into body fat or milk fat.

CRUDE FIBER is the tough, woody part of plants and consists largely of cellulose and wood fiber. These are the essential constituents of the cell walls of plant tissue. The proportion of crude fiber depends largely on the stage of growth of the plant. In young plants the cell walls are thin and delicate, while at maturity the same plants may contain a large proportion of tough fiber. Naturally coarse fodders contain a larger proportion of crude fiber than grain feeds.

Classes of Feeding Stuffs. The vegetable materials used in feeding farm animals may be conveniently divided into 2 classes: (1) Coarse fodders, including forage plants and roots, and (2) concentrates or grains, seed and the various by-products resulting from their commercial use.

The chief forage plants belong to the families of grasses and legumes. The grass family is represented by corn, cereals and common grasses, while the legumes include clover, alfalfa, peas, vetches, sainfoin, etc. As feeding stuffs the legumes differ from the grasses chiefly in the greater amount of protein which they contain. Coarse fodders as a class are distinguished from the grains by a smaller percentage of protein and carbohydrates and a larger percentage of crude fiber. Practically all of the forage plants may be fed green, dry or in the form of silage. The practice of feeding forage plants in a green state is known as soiling. (*See*

this subject.) The relative advantages of feeding fodders green, dry and ensiled cannot be discussed here except in the briefest terms. As a rule forage plants are most palatable in the green state, and sometimes more digestible. Drying forage plants in the sun under favorable conditions does not affect their feeding value appreciably except in the case of corn, sorghum or other plants with thick, succulent stems which cannot be dried quickly. In such plants a certain amount of fermentation and consequent loss in feeding value is unavoidable. Forage plants are tougher and less palatable when dry than when green. Moreover if cured under unfavorable conditions (rain, cloudiness) they become moldy and seriously damaged. Imperfectly cured hay may suffer loss in feeding value from heating in the mow or stack.

In the summer season the farmer will choose between pasturing and soiling according to circumstances. In winter the choice will fall between hays and silage. As a rule hay and silage can be fed together to the best advantage. The stage of growth at which forage crops are cut will influence the amount, composition and palatability of the crop. With the exception of legumes forage plants give the largest yield when cut at full maturity. The percentage of protein, however, decreases as the crop matures, so that probably the best returns in quantity and quality are obtained if clovers and grasses are cut in full bloom. Legumes for forage should always be cut before becoming fully mature.

Forage Crops when ensiled undergo important changes in composition, due to complex processes of fermentation. (*See Silage.*) The loss of food value in this way may vary from 2 per cent to 40 per cent, but under favorable conditions should not exceed 4 to 8 per cent. The loss in ensiling is not greater than that in field curing. In fact the results of experiments are slightly in favor of silage, as being the more economical way of preserving fodder.

Roots of various kinds are extensively fed to farm animals. The more important are turnip, rutabaga, field beet, sugar beet, mangel-wurzel, carrot, potato and cassava. Roots contain a relatively large amount of water. Their chief advantage is that they furnish a large amount of appetizing, succulent food which keeps fresh during the winter. They are easily preserved by keeping at a low temperature with good ventilation. If fed in proper proportions roots may be substituted for soiling crops, hay or silage. For details see experiments in feeding under the different farm animals. Roots may be fed raw, cooked or ensiled. There is little, if any, advantage in ensiling roots and most authorities advise against the practice. As a rule feeding stuffs are made less digestible by cooking. Some roots, especially potatoes, may be rendered more palatable by cooking.

Grains and Seeds contain relatively little water and large amounts of protein, starch and oil. The chief grain feeds are corn, barley, oats, wheat, rye, rice, Kafir corn, millet, buckwheat, cottonseed, flaxseed and the different kinds of beans and peas. Peas, beans and oats are rich in protein, corn is especially rich in starch, while cottonseed and flaxseed have a high oil content. Experiments indicate that there is no advantage in cooking grains. The economy of grinding grains has been extensively studied and the results are fairly uniform. The digestibility of grains is increased by grinding and there is less waste of grain in the manure. If a mill is near at hand and the miller's toll is not high, it may pay to grind grain. If grinding adds 10 per cent to the cost of the grain the practice is of doubtful economy. Corn may be most economically fed to steers without even husking.

Commercial Feeding Stuffs. From milling and from the manufacture of special food articles from grains, a number of materials suitable for feeding farm animals are obtained. The more important of these may be briefly considered in this place.

Bran is the common term for the ground outer hulls of grains. Wheat bran is most extensively used. It is ordinarily fed to horses only once or twice per week. Bran is one of the best dairy feeds and is also excellent for fattening steers, sheep and lambs.

Middlings and Shorts are terms commonly used interchangeably. They contain bran and the outer part of the kernel of grains. Middlings are better feed than bran for young pigs. The middlings of all grains are good feeds for fattening animals.

Oat Feed consists of the hulls and a portion of the kernels of the larger oat grains, together with the smaller grains which are not used in the manufacture of breakfast foods. Sometimes the oat hulls alone are sold as oat feed. Such material is of inferior value. Oat feed,

when honestly made, may be substituted for oats in feeding animals.

Barley Feed consists of the hulls and a part of the kernel of barley. Its feeding value is not equal to barley.

Corn furnishes a large number of commercial feeding stuffs, of which some of the more important may be mentioned. Hominy chops consists of a part of the starch, the germ and hull of the corn kernel. This feed closely resembles whole corn in composition. "Sugar corn" consists largely of the hulls and germs of corn. Gluten feed contains the hulls and gluten layer of the kernel, and gluten meal is made from the hard part of the kernel. Gluten meal contains the most protein and is a highly nitrogenous feed.

Brewers' Grains is a term used for the crushed grains (usually barley) after the sugar has been extracted for brewing. They contain relatively more protein than whole barley. Wet brewers' grains should be fed fresh, before they have undergone fermentation. They are extensively fed to dairy cows and are very valuable for this purpose. Brewers' grains, when dried, form a more concentrated feed. They may be shipped long distances and are easily preserved in good condition. Dried brewers' grains may be fed to dairy cows and are also useful for feeding horses and steers. They are less valuable for swine.

Malt Sprouts are the barley sprouts formed during malting and are later separated from the dried grains. They are highly nutritious but are not much relished by farm animals and hence must be fed in small quantities. They should be soaked before feeding.

Cottonseed Hulls are removed from the cottonseed preparatory to extracting cottonseed oil. The hulls are a low grade feeding product and are to be classed with coarse fodders. They are extensively fed in the Southern States in combination with cottonseed meal in the proportion of 3 to 6 parts hulls to 1 part meal.

Cottonseed Meal. The hulless kernels are cooked and then subjected to high pressure, by which the oil is removed. The process has been perfected so that the resulting by-product contains less oil than formerly. The pressed cakes are ground to form cottonseed meal. This product is highly nitrogenous and is one of the most valuable and effective stock foods. It is especially adapted to fattening steers and feeding milch cows. It is injurious or even fatal to pigs, calves and chickens if fed in long periods. When fresh and pure it should be of a light yellow color, and it should be fed only in this condition. Cottonseed feed is a mixture of the hulls and meal (usually in the proportion of 4 to 1), and its feeding value is less than that of the meal. (*See* also under *Beef Cattle, Sheep, Swine* and *Dairy Cows.*)

Linseed Meal is a by-product of the manufacture of linseed oil from flaxseed. The "old process" consisted in subjecting the seeds to pressure, either while cold or after warming. By the "new process" the oil is extracted with naphtha. The old and new process linseed meals are almost identical in composition, except that the new process meal contains much less oil. Linseed meal contains a high percentage of protein. It has a beneficial effect upon the health and appearance of all farm animals. It may be fed to cows in rations of 8 pounds per day. Horses should receive only occasional feeds of linseed meal. It may be fed to skim milk calves to replace the fat of whole milk. Flaxseed, cooked or ground, may be fed to calves and other farm animals, but it contains more oil than linseed meal and should be fed sparingly on account of its laxative effect. (*See* also under *Beef Cattle, Dairy Cows, Sheep* and *Swine.*)

Feeding Stuffs of Animal Origin. The feeding of milk (whole or skimmed), buttermilk and whey is discussed under *Pigs, Calves* and *Colts.* Slaughterhouse refuse, meat scraps, meat meal, bone meal, dried blood, tankage, ground fish, etc., are much used as feed for poultry, and to some extent for hogs. These feeds contain relatively large amounts of protein.

Rations. All writers on feeding problems use the term nutritive ratio to signify the ratio between the digestible protein and the other digestible matter in any food stuff. In calculating the nutritive ratio the quantity of digestible ether extract or fat is multiplied by 2.4, since fats have 2.4 times the heat value of carbohydrates. The resulting quantity is added to the total amount of carbohydrates and the sum is divided by the amount of digestible protein. Thus timothy hay has 3 per cent digestible protein, 43.9 per cent digestible carbohydrates and 1.2 per cent ether extract. The nutritive ratio of timothy may therefore be computed as follows: 1.2x2.4 equals 2.88. This quantity added to 43.9 gives 46.78. By dividing 46.78 by 3, the amount of digestible protein, we obtain 15.5. The nutritive ratio of timothy is therefore expressed by 1 to 15.5. This is called a

"wide ratio," on account of the large amount of carbohydrates as compared with the protein. The nutritive ratio of corn is 1 to 9.8, and this is considered a "medium ratio," while a good example of a "narrow ratio" is found in linseed meal, with a nutritive ratio of 1 to 1.7.

From the above discussion it may be seen that wide ratios may be made up almost or quite entirely of coarse fodders, and are therefore cheaper than narrow ratios, in which the increase of protein must be furnished by relatively expensive grain feeds. Wide and narrow rations are adapted to different purposes and should be fed with an understanding of their effects.

A ration which is fed for the purpose of maintaining an animal without gain or loss in weight is called a maintenance ration. Such rations may obviously be quite wide, since a relatively small amount of protein is required. Animals may be maintained upon good pasture or hay without grain. The best example of a maintenance ration of coarse fodder alone is furnished by grazing conditions in the Western States, where cattle, horses and sheep maintain themselves exclusively on the native grasses and weeds. About 15½ pounds mixed hay or 12 pounds timothy hay and 3 pounds wheat bran per day or their equivalents are required to maintain a beef animal of 1000 pounds' weight. For a 1000-pound horse 16½ pounds mixed hay, or 10 pounds timothy hay and 5 pounds oats, may be considered a maintenance ration.

In general, narrow or medium rations are more effective in the production of milk or for young growing animals, while wide rations are most effective and profitable for fattening animals. Protein seems to exercise a stimulating effect on the formation of milk, and experiments indicate that the quantity of protein in the average ration which is fed to dairy cows could be considerably increased with profit. Young growing animals, especially if they are to be used for breeding purposes when mature, require an abundant supply of protein in order to secure a vigorous development of all parts and organs. The effect of withholding nitrogenous food materials from growing animals is seen in the smaller size of the heart, lungs, liver and kidneys and the softness of the bones. The bones may become too weak to sustain the weight of the body.

For fattening animals, particularly if the feeding period is to be short, a wide ration is as effective, or more so, than a narrow ration. Whole corn or corn meal may be fed as the exclusive grain feed, or with an occasional addition of small quantities of wheat, oats, peas or beans. Where Kafir corn is grown it may be substituted for corn, and cassava may serve in part as a cheap substitute for corn. Hundreds of experiments have demonstrated that for fattening animals a moderately wide and cheap ration, with corn as the chief grain feed, is equally as effective as narrow rations containing more costly grains.

The numerous feeding experiments which have been made in this and other countries have demonstrated conclusively that the cost of gain in weight is greater at the end of a fattening period than at the beginning. Animals should therefore be put in market condition as quickly as possible. It has also been shown that the cost of gain increases and the rapidity of gain decreases with the increase in the age of the animals. For a discussion of these points *see* under *Swine, Beef Cattle* and *Sheep*.)

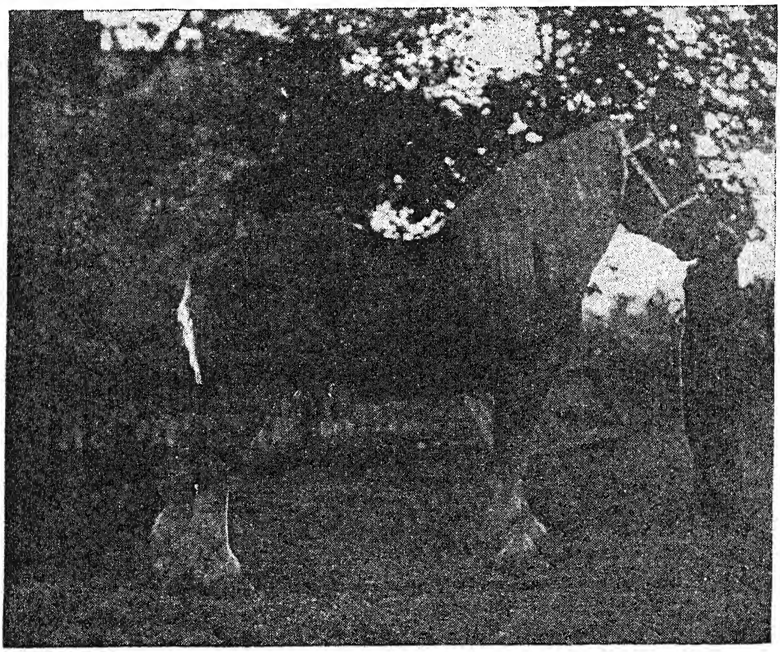
It has been found that cattle, sheep and pigs vary to some extent in their ability to make economical use of feeding stuffs. Up to the age of 3 months calves may make better gains than pigs on the same feed. In older animals, however, pigs make more economical gains than cattle. The following table, compiled from 75 or more experiments with 500 or more animals of each kind, indicates the average amount of different grains required for 100 pounds of gain in pigs, sheep and cattle.

Grain Required for 100 Pounds of Gain

	Barley Lbs.	Corn Lbs.	Kafir corn Lbs.	Oats Lbs.	Peas Lbs.	Wheat Lbs.	Mixed grains Lbs.
Pigs	418	485	529	472	439	452	432
Sheep	453	502	582	518	422	582	454
Cattle	914	1028	1058	1032	911	1090	871

It is generally found in feeding experiments that mixed grain feeds are more effective than single grain rations. In the above table it is also observed that the average amount of mixed grain feed required for 100 pounds of gain is less than the average of any 3 grains fed separately.

The reader who has followed the discussion of rations for farm animals and particularly the results reported from feeding different kinds of hay, silage, grain and other materials to livestock cannot have failed to notice how much at variance, and often quite contradictory those results were. But that need cause no question of the accuracy of the experiments. Probably no two samples of alfalfa, or barley or turnips are exactly alike in chemical composition. Nor were the animals all of the same age, or of the same breeding, or kept under identical conditions. One cow may be far more nervous and irritable than another, or may not boast of as good digestion, or may not be capable of producing as much milk from the same amount of feed. I have known of cows that could not be persuaded to eat silage or sweet clover hay, while their companions seemed to consider those feeds as delicacies. Of late we hear a great deal about human beings who are totally allergic to this and that article of diet, which may be eaten by the rest of us with great gusto. Why might not a cow be allergic to turnips, or a horse to buckwheat? Under the conditions of the experiments the results were as reported for each case. There is nothing strange in the fact that the results of feeding cottonseed meal and sorghum stover to steers were not always the same in the hands of every experimenter in every State in the Union, since such experiments began. From the innumerable experiments, however, which have been made with all kinds of live stock, with all sorts of feeding stuffs, in different localities, the farmer can derive many useful suggestions on how to prepare suitable rations for his livestock from the feeding stuffs which he has available.



BELGIAN STALLION

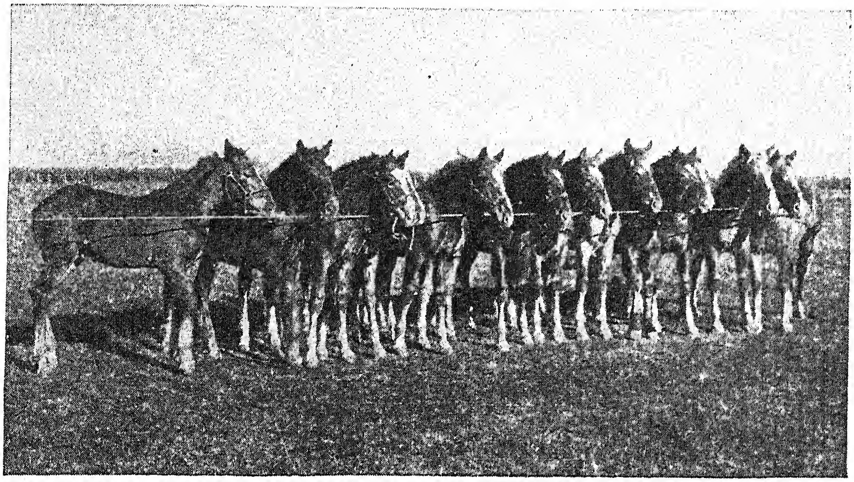
HORSE

Horses stand in a peculiar relation to agriculture and are raised for different purposes than those which govern the production of other domesticated animals. While in European countries horses are used extensively for food, this practice has not become common in the United States. The main purpose in breeding

horses is to secure motor power, either for slow or rapid work. The fact that farmers usually wish to maintain good horses for as long a period as satisfactory service can be obtained from them renders the care, feeding and management of these animals of unusual importance. With the majority of domesticated animals, except dairy cows, the common practice is to bring them to a market condition as soon as possible, and an attempt is usually made to secure this result before they have had opportunity to become infected with disease. With horses, on the other hand, the long service which they are expected to render subjects them to contagion and various diseases and to injuries which may result in impairing their usefulness. These facts make a study of the diseases of the horse of special importance.

The production of horses, like that of other animals, is subject to fluctuations, such as that caused by shortage of gasoline, which has stimulated their production. According to the latest census there are at present 9,850,000 horses in the United States.

The period of pregnancy in the horse is on an average 11 months, or 330 days. The weight of the foal at birth, from mares weighing 900 to 1100 pounds, is about 100 pounds, and the increase of weight varies from 1 to 3 pounds per day during early development. Naturally the weight of foals of different breeds at birth and their rate of growth vary to a large extent. According to experiment of Boussingault the normal variation in the weight of horses at different periods on the same ration and at the same kind of work may be 25 pounds or more. It has been shown that irritation of horses by the presence of flies or other annoyances may cause a sudden and rapid decrease in weight. During heavy work large quantities of water are lost through perspiration, and a decrease in weight of from 7 to 33 pounds in the working hours of a single day has been observed. The amount of work which horses are capable of performing under different conditions has been accurately determined by means of apparatus devised for that purpose. In general, it is known that the amount of work varies inversely with the speed. Horses are capable of doing a much greater amount of work at a slow speed than when driven rapidly. Experiments have shown that horses are capable of doing the most work at a speed of 2 miles per hour. The effect of severe work or rapid driving on the digestion varies somewhat in different horses, but usually the digestive process is somewhat checked by violent exercise.



CLYDESDALE FOALS

The great majority of horses in this country are raised on farms as a side line by men who are chiefly interested in other branches of agriculture. As a result of these conditions many farmers give insufficient attention to the breeding of horses, and therefore produce an undue proportion of unclassed or nondescript animals which do not satisfy the market

requirements and cannot be sold for a profitable price.

The Indiana Stallion Enrollment Board reported that the low prices for horses from 1938 to 1941 resulted in fewer mares being bred than in the previous 5 years. The growing demand for horses since 1941, however, is reflected in the increased business of registry associations. Trucking companies are planning to use horses for short hauls in cities.

"During the past 3 years the rate of mare breeding has fallen far short of maintaining the present number of horses and mules on farms. Thrifty farmers will do well to breed their good mares to good stallions.

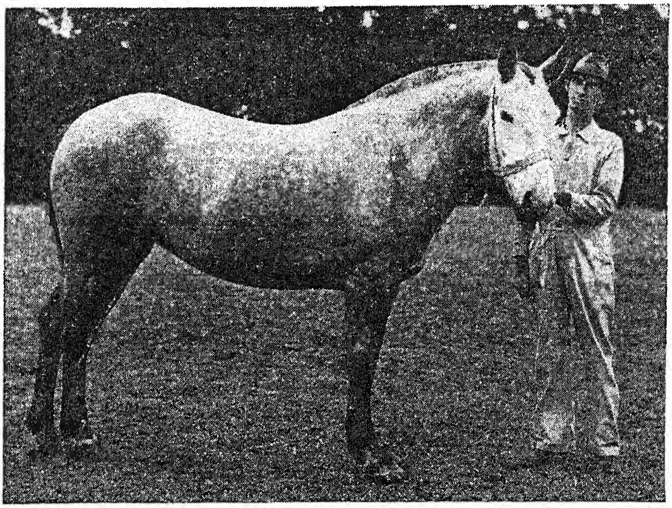
"Make your horse power more efficient by using modern tandem hitches. Such hitches offer the following distinct advantages:

"1. They conserve man power by enabling one man to easily drive and control large teams of 4, 5, 6, 8, or even more horses with only 2 lines reaching to the leaders.

"2. They enable one man to perform two or more field operations at one time by pulling a combination of implements, such as a gang-plow with a harrow attached, or a disk with a harrow pulled behind.

"3. They keep horses cooler in hot weather."

Market Classes of Horses. In the Chicago market 5 classes of horses are recognized: The carriage horse, cab horse, bus horse, draft horse, and American trotter. The carriage horse should be from 15 to 16 hands high and should weigh from 1000 to 1200 pounds. Bays, blacks, browns, sorrels and chestnuts are preferred. Peculiar markings and grays are not in favor. The animals should be round barreled, with large nostrils, small, clean heads, and should exhibit prominent veins on the face and limbs. Cab horses are raised for light delivery work. They should be from 15 hands to 15 hands and 2 inches in height, should weigh from 1050 to 1100 pounds, and should exhibit some style of action and ability to travel at a moderate pace, combined with power to haul medium loads. The bus horse of the Chicago market is the typical general purpose horse. The animal should be fitted to haul light loads at a fair rate of speed, should stand from 15 to 16 hands high, and should weigh from 1250 to 1500 pounds. The draft horse has but one use, and that is to haul heavy loads at slow speed. Strength is the first consideration. The animal should weigh from 1500 to 2000 pounds, should possess short back and should be closely coupled; the pasterns should be short, the hips broad and the bones large. The trotting horse requires too much attention for its successful production and can scarcely be raised economically by the average farmer. In breeding carriage horses the best stallions are American trotters, Morgan, Hackney or French Coach. Whatever breed is chosen, the mare should be

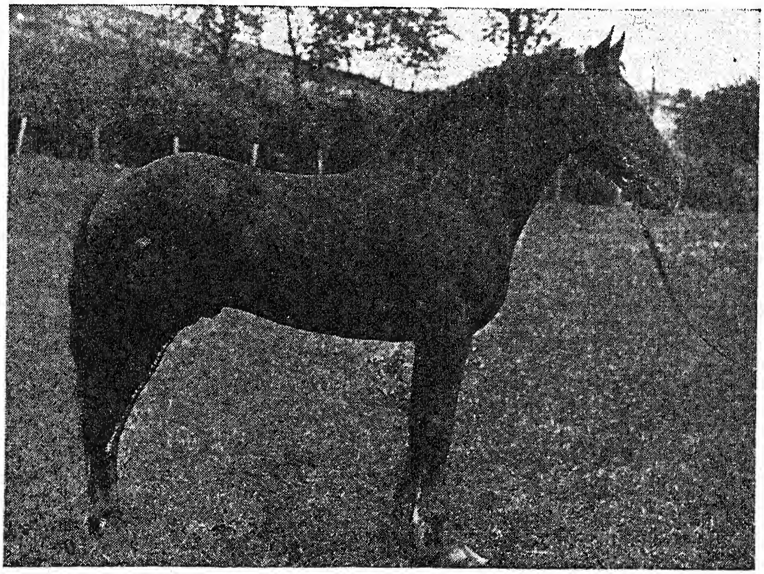


PERCHERON MARE

of good form and should show tendencies to produce speed and style rather than weight and strength. In the production of general purpose or bus horses perhaps the best results can be obtained by breeding a Percheron stallion to a small mare with good action and well-developed bones. For draft horses only stallions of the best draft breeds should be used, and the mares should always be of large size and strength.

Management. The management of horses varies greatly according to the number possessed by any one man and according to the general conditions. In the Eastern States as a rule each farmer owns but a small number of horses, and these animals are always stabled or given shed room during winter and severe weather. In summer they are allowed to run, as a rule, upon cultivated pasture when not at work. The methods of feeding working horses do not vary greatly in different parts of the country, although the feed used differs according to the prevailing crop of the country. In the Western States, where horses are raised on a large scale, they are for the most part allowed to run on the open range the year round. Occasionally losses are suffered from this method of management, and during recent years most horse raisers provide hay for use during the time when the ground is deeply covered with snow. As a rule the horses which have been produced on the Western plains have been of low grade and not well adapted to Eastern markets. They possess, however, great stamina and are especially well suited to driving or riding long distances on rough and heavy roads. The price of range horses has been as low as $10 to $15 per head.

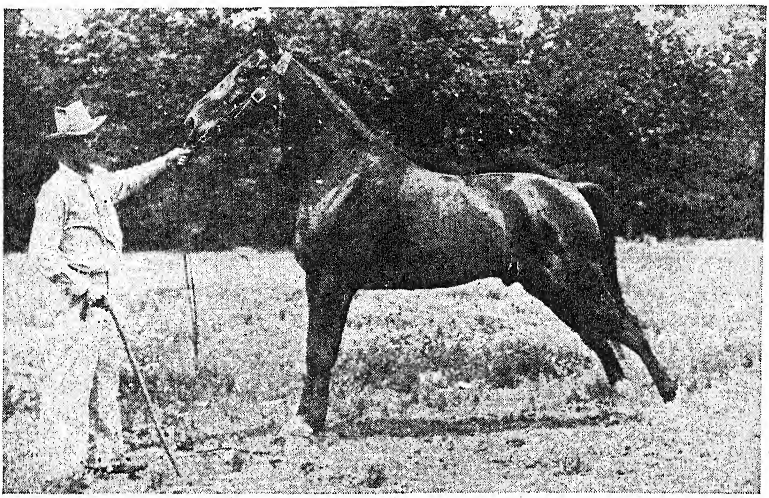
Experiments at the Utah Station indicate that when horses are covered with blankets in the harness by day and blanketed also at night they do not retain their weight as well as horses without blankets. In later tests horses were irritated by blankets while at work. This does not prove that blanketing is not a good practice, but shows that excessive loss in weight may be caused by increased perspiration during heavy work under blankets.



PERCHERON STALLION

A loss of appetite is frequently observed in horses under different conditions, and may be due to sore mouth, irregularities of the teeth, overfeeding or improper ration. The mouth may be made sore by punctures from grasses with sharp awns, such as the foxtail grass of the West. Irregularities in the teeth are indicated by the presence of uncrushed grain in the dung. The teeth should be examined from time to time in order to detect the presence of sharp points or other irregularities, especially

on the grinders. An appetizing food recommended by the Rhode Island Station consists of 5 pounds oats, 5 pounds corn meal, 1/4 pound oil meal and 2 ounces of salt, with the addition of a spoonful of powdered gentian and sulphate of iron as a tonic. Experiments have shown that systematic feeding in the right quantities and at the right time, with proper rations, prevents in a large degree the development of colic and other digestive disturbances which may interfere seriously with the work of a horse in careless feeding.



THOROUGHBRED STALLION

The Age of a Horse Determined by the Teeth. At birth the foal commonly has no teeth in the front of the mouth and only 4 grinders in each jaw. After a few days the middle fore teeth appear, and after a month another grinder breaks through on each side of each jaw. After 4 months the intermediate fore teeth appear, and at the age of from 6 to 8 months the side fore teeth or corners appear and another grinder on each jaw. The set of milk teeth is then complete. At the age of from 13 to 16 months the cavities in the face of the middle fore teeth are effaced or razed, and the same process takes place in the corner teeth at the end of the second year. The shedding of the teeth and the beginning of the second or permanent teeth occur at from 2½ to 3 years of age. The first or milk teeth may always be recognized by their shortness, whiteness and by a constriction or neck. The middle front teeth are shed first, and intermediate ones follow at the age of from 3½ to 4 years, and the corner teeth are shed at from 4½ to 5 years of age. The determination of the age of horses between the years of 5 and 10 may be made with considerable certainty by experts from a study of the front of the lower and upper jaws. Naturally these teeth undergo a progressive wearing process which changes their appearance as the animals grow older. In general it should be remembered that the shape of the front teeth gradually changes with age; in young horses they are wider from side to side than from front to back, while in very old horses they become wider from front to back than from side to side, having in many cases a triangular shape. As already indicated, a horse's mouth is said to be full, or dentation is complete at the age of 5 years. At 6 years of age nippers become worn down even with the middle teeth; the inner edge of the corner teeth is also worn off. At 7 years of age the tushes show a dull, rounded point, both edges of the corner teeth are worn smooth, and the cavity on the face of the teeth is small. From this age until 10 or 11 the incisor teeth of the upper jaw are usually examined for determining age. The age is now indicated approximately by the amount of wear upon the face of the teeth and by the gradual disappearance of their marks or cavities. The marks on the corner teeth become obliterated at the age of from 7 to 8 years; the same processes take place in the fore

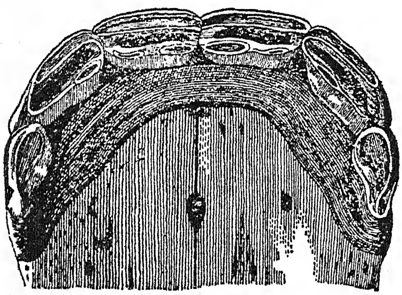
teeth of the upper jaw more slowly, and when these changes have occurred in the upper teeth the horse may be looked upon as 10 years of age or older.

Vices. Among the various vicious habits which horses may develop under improper or cruel treatment only one will be mentioned in this connection. Cribbing may become a very injurious habit. Horses addicted to this habit seize the edge of the manger with the teeth and bite the wood continuously, sometimes drawing in air with a sucking sound; this form of cribbing is commonly known as wind-sucking. The most effective remedy for this vice consists in the use of an open iron muzzle which keeps the teeth away from the edge of the manger, and which may be furnished with concealed goads which prick the lips if an attempt is made to continue the habit.

Water. Many experiments have been conducted to determine the amount of water required by horses under different conditions. At the New Hampshire Station it was found that the amount of water taken by horses depended on the nature of the ration, on the work performed and on the individuality of the horse. The amount of water required appeared to depend more on the individuality of the horse than on the amount of work or ration. The largest amount of water was drunk on a bran ration, and the least on a corn and linseed oil meal ration. The amount taken by different horses varied from 25,895 to 32,997 pounds per year. At the Oklahoma Station it was found that work horses drank on an average 107 pounds of water per day. At the Maryland Station experiments indicated that horses should be

PLOWING IN AROOSTOOK COUNTY, MAINE

watered 3 times a day when at rest, but frequently and in small quantities when at work—never immediately before or after feeding. At the Utah Station, however, it was found that horses watered before feeding grain retained their weight better than those which were watered after feeding grain, and had better appetites. The grain was digested equally well whether the horses were watered before or after feeding, and it is recommended that the animals should be watered both before and after feeding on grain. The amount of water drunk by horses is smallest when the diet contains a large percentage of grains, and is greatest when the ration contains a large amount of coarse fodder. Less water is



HORSE'S TEETH, ONE YEAR OLD

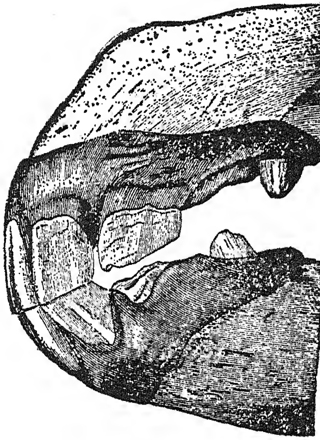
required on alfalfa than on a timothy ration. The excessive loss of water by perspiration during hard work shows clearly that working horses should be given water at frequent intervals, and experiments have shown that horses are not injured by taking small quantities of water, even during the most violent exercise and when heated and sweating profusely. The animals suffer far more by being compelled to wait for the water until they are completely dry and cool than from allowing small drafts of water at frequent intervals. (*See* also *Order of Giving Hay, Grain and Water* below.)

Grains for the Horse. Horse rations always contain a quantity of some kind of grain. The particular grain which is most used and most prized in different localities depends largely upon the abundance and cheapness of different grains in each section of the country.

OATS are generally considered, especially in the Northern States, as the standard grain for horses. Many horse raisers firmly believe that it is the only grain from which perfectly satisfactory results in feeding may be obtained. Oats are readily digested by horses and furnish an abundance of nitrogen. They may be fed in large quantities, causing no ill effects. The idea, however, that oats are the only proper feed for horses must be abandoned. The Arabian horses receive barley as an exclusive grain feed, and barley is the chief grain feed for horses in California and some other Western States. In the Southern States corn is used almost exclusively and with good results. Oats may simply be considered a standard grain feed for horses, and other grains may be substituted for oats in certain proportions, as will be presently explained. Some authors have maintained that oats possess a peculiar property, supposed to depend upon a substance known as avenine, which gives a desirable life and spirit to horses. It has been maintained that no other grain has this peculiar effect. The existence of this substance, however, has been denied by other investigators, and apparently as good results in spirit and action have been obtained from feeding other grains. When too expensive, oats should be replaced by some other grain, such as corn, barley, dried brewers' grains, or a portion of the oat ration should be replaced with these grains and wheat, or even buckwheat. According to some experiments oats are better digested when ground than when fed whole. Perhaps this grain is better digested by young horses than by old animals, and this may be due to imperfections in the teeth of old horses. With young animals which possess perfect teeth and good digestion there is apparently no sufficient reason for grinding oats before feeding. In an experiment in which oats were compared with a mixture of gluten meal, linseed meal and middlings for young colts, a greater growth was obtained from the mixture than from the oats alone. At the Maine Station slightly better gains in weight were obtained in colts fed on a mixture of pea meal and wheat middlings than from those fed on oats. The mixture was a cheaper food, and it is concluded, therefore, that oats are not a necessary grain ration for colts. Oats may be fed to the extent of from 8 to 20 pounds per day, according to the size of the animal and the severity of the work. In the Rocky Mountain and Pacific Coast States oats are frequently cut when the heads are in an immature condition, and in this form the whole crop is fed to horses and other animals. In some localities 2 crops per year are obtained Smutty oats should not be used, since

they may produce colic or more serious disturbances.

Barley, as already mentioned, may be substituted for oats pound for pound, or in slightly larger quantities than the oat ration. It is better fed ground than whole. It appears to produce more fat than oats, and according to some experiments, appears to exercise a depressant effect on horses. At the North Dakota Station experiments showed that barley was not quite equal to oats as a horse feed, and that malted barley was inferior to whole barley. It is much used as horse feed in oriental countries, Spain, and in the Western States, especially in California. Lavalard's experiments showed conclusively that barley could entirely replace oats in the ration for all kinds of horses, whether for driving or draft purposes, but that it must be fed in slightly greater quantities than oats.



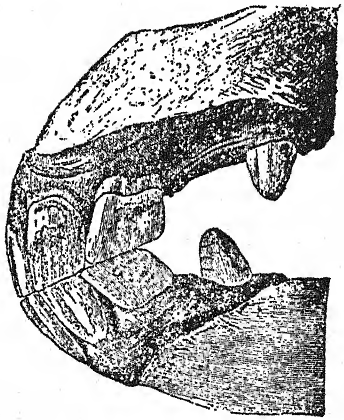
FOUR AND ONE-HALF YEARS OLD

Beans of all varieties are fed to horses in common practice, and several experiments have been conducted to determine their feeding value. Lavalard found that beans could be substituted for oats in the ration of all classes of horses; that horses fed on beans showed no greater endurance than those which received oats. Beans are also recommended for stallions in service and for hard-working horses. Beans should be fed in about ½ the quantity of an oat ration, and straw and other coarse fodder should be added to the ration. Horse beans are especially recommended for horses at hard work. They are remarkably effective when used to replace 2 or 3 pounds of the oat ration. They may prove injurious to horses with thick wind or especial susceptibility to founder. Fresh horse beans occasionally cause colic. They should be fed cracked and only after lying for a year or more. The soy bean may enter largely into the horse ration, and Lavalard regards it as in some respects superior to other kinds of beans. In substituting for oats, ½ pound is equal to 1 pound of oats.

Bran may be substituted for oats in the horse's ration, either in summer or winter. At the New Hampshire Station it was found that bran contained the same amount of digestible material as oats. Undue quantities of bran may make the horses soft and inclined to sweat profusely. At the North Dakota Station bran and shorts mixed in equal parts were found to be equal to oats in feeding value, and in further experiments they proved to be slightly superior.

Buckwheat may be fed whole, but should usually be crushed or ground. It may be given in feeds of 4 to 6 pounds to replace that quantity of oats. In some horses it causes sweating and colic. In feeding value it stands between oats and barley, according to Wrangel. In some parts of Europe good results are obtained from feeding horses a bread made of buckwheat flour.

Cottonseed Meal is an excellent horse feed, at the rate of 2 to 2½ pounds per day. At the North Dakota Station it was readily eaten and caused no digestive disturbances or loss of appetite. At the New Hampshire Station it was not greatly relished by the horses, but was the cheapest of all rations with which experiments were made. In Louisiana 1 or 2 pounds per day were fed to mules with success. The



FIVE YEARS OLD

maximum safe feed was found to be about 6 pounds.

CORN is, next to oats, the most important grain for horses, in fact, numerous and extensive experiments by street car companies in this country and in Europe have shown that its feeding value is equal or in some cases, superior to that of oats. As already stated it is the principal grain feed of horses and mules throughout the Southern States. At the Utah Station corn sustained the weight of horses better than oats. A ration containing corn and oats proved of greater value than one containing oats alone, and at the North Dakota Station it was found that 77.5 pounds of corn equaled 100 pounds of oats for work horses. Lavalard found that corn could be substituted for oats in the rations of driving, work, cavalry or artillery horses. In his experiments corn gave results which were equal to those obtained from oats in the muscle, health and spirit of the horses. At the Oklahoma Station excellent results were obtained from feeding work horses 30 pounds of corn in the ear and 31 pounds of Kafir stover per day. The Maryland Station found that corn meal was more readily digested than shelled corn; the horses had better appetites when fed on the meal, especially in the case of old animals.

DRIED BREWERS' GRAINS, at the New Jersey Station, were found to be equal to oats, pound for pound. Horses ate them with relish and remained in good condition. Subsequent tests at the New Jersey Station showed that dried brewers' grains were equal to the same weight of a mixture of wheat, bran and linseed meal.

KAFIR CORN and Kafir stover were extensively fed to horses at the Oklahoma Station. Kafir corn was not eaten clean by some of the horses, but it was considered a safe, economical and valuable feed.

LINSEED OIL MEAL may be given to the extent of 4 pounds per day with no ill effects. A change may safely be made from a ration containing the oil meal to one without it, if proper substitutions are made. Flaxseed has a laxative effect, and mixed with oats is an indispensable supplemental feed in derangements of the digestion. It should be cooked into a pasty mass and then mixed with the other feed.

MILLET seed is recommended by Stewart for horses of all ages as being adapted to maintain muscular strength. It should constitute only a portion of the grain ration and should be ground. It should not be given continuously for a long period. At the North Dakota Station millet cut just before becoming mature and fed as exclusive coarse fodder produced increased action of the kidneys, lameness and swelling of the joints and a softening of the bone structure. In a few cases extensive feeding resulted fatally. These observations have not been generally confirmed.

PEAS constitute an excellent and highly nutritious horse feed. They are about equal to beans in feeding value. Peas occasionally exercise a somewhat constipating effect. Stewart found that a ration containing 8 parts of peas, 8 parts of corn and 1 part flaxseed, the whole being ground together, gave satisfactory results with work horses. Peas are extensively fed to street car horses in Europe. Pea meal was fed by Stewart to the extent of 16 pounds per day, mixed with 1 bushel of cut hay. The ration was found to be well adapted to sustaining the weight and strength of horses at hard work.

RYE may replace ⅓ of the oats in the grain ration. It should be cooked or moistened. If infested with ergot it may cause serious disturbances, and therefore should be fed sparingly until it is demonstrated that the grain is clean. Stewart found that rye ground and mixed with hay formed a healthy and suitable ration. The composition of rye from different localities was found to vary considerably. Rye bran may be mixed with new corn for the purpose of preventing scouring.

WHEAT, when fed whole, was found to be an unsatisfactory ration at the North Dakota Station. The horses lost appetite and refused to eat the grain after a time. When ground and mixed with bran it gave excellent results. Whole wheat was found to be no better, and probably not so good, as an equal quantity of bran and shorts, while a ground wheat and bran ration gave better results than did oats for horses at light work. In Sweden experiments showed that wheat was superior to rye, and it is therefore recommended as a horse feed, mixed with an equal quantity of oats. During hard work 10 pounds per day may be given with oats. It has been found to have a beneficial effect in building up the muscles of horses which were run down by hard work and in sustaining them during excessively severe labor. When fed in large quantities it may cause digestive disturbances.

At the Iowa Station greater gains were obtained in colts by feeding on ground

rather than on whole grain. The grain in these experiments was oats, corn and rye. These results were confirmed by further experiments. One lot of colts received corn and cob meal and bran, and the other shelled corn and whole oats. Better results were obtained on the first ration. It was found in these experiments that weanlings required about 7½ pounds of grain for 1 pound of gain, while yearlings required 11 pounds. At the Utah Station whole grain was found to be equal to ground grain for work horses, and from the expense of grinding it was concluded that grain must be from 15 to 20 per cent more effective when ground in order to pay for the grinding. Later experiments indicate that grinding was unprofitable. The question of whether grain shall be ground or not before feeding is largely a practical one and depends principally upon the kind of grain which is fed and upon the condition of the horse's teeth and digestion. When the teeth are in good condition there appears to be no good reason for grinding oats or wheat or barley, when these latter grains are substituted in part for the oats.

A TOO-SLOPING PASTERN

Coarse Fodders for the Horse. In the Northern States timothy is the standard hay for horses and is considered by many as the only satisfactory hay. In the Southern States, however, corn stover constitutes the chief coarse fodder, and in the West alfalfa, barley, wheat, oats and wild oats are cut for hay. The coarse fodder which is chosen for horse feed in any particular locality will depend upon the crop of this kind which is most abundant and cheapest.

Alfalfa is abundantly fed to horses throughout the Western States. Practical experience shows that it is superior to timothy in feeding value. When fed green it may cause digestive disturbances if horses are unaccustomed to eating it. When dry and clean, however, these effects are not noticed. Wherever alfalfa is one of the chief fodder crops it largely replaces clover, timothy and other grasses as coarse fodder for horses and other domesticated animals. In Wyoming 13.5

pounds of alfalfa proved a daily maintenance ration for horses allowed the liberty of a straw stack. In Utah, Merrill found that 20 pounds per day was enough to maintain a horse weighing 1400 pounds when at rest. Alfalfa proved superior in every way and produced no bad effects after long continued feeding. Alfalfa and clover when cut into fine pieces resulted in greater gains than when fed uncut.

Brome Hay, in experiments at the North Dakota Station, proved to be equal or slightly superior to timothy. This crop has not come into great economic importance in this country, but wherever it is grown in quantities sufficient to make the market price reasonable, it may be substituted for timothy pound for pound.

Clover Hay has been found to be more nutritious than timothy, but is feared by nearly all horsemen on account of its tendency to produce heaves and other disturbances in respiration when fed in a dusty or unclean condition. These objections, however, do not apply to clean, properly cured clover hay, and there seems to be no good reason why it should not be fed extensively when preserved in good condition. At the Utah Station it was found to have a much greater feeding value when chopped fine.

Corn Silage at the Virginia Station proved to be a good roughage for horses when fed in connection with hay or corn stover, but it is recommended that horses be gradually accustomed to it before receiving full feeds. Moldy or improperly fermented corn silage may produce serious digestive disturbances or death with symptoms resembling those of cerebrospinal meningitis.

Corn Stover at the New Hampshire Station was found equal in feeding value to timothy hay. The large yield per acre makes it an economical feed. Further tests at the same station indicated that corn stover was slightly superior to timothy. It should also be remembered that it is usually much cheaper.

Pea Pods and Straw are fed in many parts of the country as a substitute for hay. They closely resemble timothy hay in composition, and when cut fine were found by Lavalard to be more easily digested. In Montana it was found that horses could be successfully maintained at hard work on a ration of pea straw with a small feed of grain. The pea straw, however, had a slightly irritative effect upon the kidneys, and it was found desirable to alternate occasionally with other coarse fodders.

Straw may be used as a substitute for hay in any ration. It is, however, not equal to the best grades of hay. In relative feeding value the different kinds of straw stand in the following proportion: Oats, barley, wheat, rye. Oat straw is a very satisfactory feed. Horses require ¼ more grain, however, when fed straw than when fed hay. At the North Dakota Station it was found that the saving in hay more than balanced the extra cost of grain, and the straw ration was therefore cheaper.

Timothy is less completely digested by horses than by ruminants. It is, however, eaten with great relish, and as already indicated, is preferred by nearly all horse raisers. At the Maryland Station it was found to be somewhat inadequate for maintenance when fed alone. In Utah, timothy when cut up fine produced sore mouth.

Roots and Miscellaneous Feeds. A number of experiments have been made to test the feeding value of different roots in horse rations. As a rule these feeds are given, not solely for their nutritive value, but for the medicinal effect which they may exercise upon the digestive organs or upon the kidneys.

Artichokes are readily eaten by horses. They may be substituted for half the hay ration with good results. For this purpose about 30 pounds per day were required.

Carrots exercise a laxative effect and stimulate the stomach and kidneys. They are recommended in colds and digestive disturbances, but cause sweating and should not be fed to hard working horses except sparingly. They should be fed cut fresh in thin slices.

Potatoes have not proved suitable as feed for high-bred horses. They are not readily digested and may occasionally cause abortion. They should always be cooked, and may then be fed to common horses in the proportion of 12 pounds to 5 pounds of hay.

Rutabagas are usually fed as appetizers. They are eaten in large quantities by horses, but have small nutritive value.

Sweet Potatoes have been substituted for a part of the grain in horse's rations in amount up to half of the grain ration at the rate of 3 pounds of sweet potatoes for 1 pound of corn. On this basis an acre of sweet potatoes, yielding 150 bushels, is equal to an acre of corn with a yield of 50 bushels.

Milk was found to give highly satisfactory results in feeding colts at the

Iowa Station. When the mare's milk is too scanty, new cow's milk can be given to the extent of 2 quarts per day, and later may be replaced with skimmed milk, which may be increased to from 4 to 6 quarts per day, and may be fed until the colts are 1 year old. It produces rapid gains and good quality in colts and may be fed to them with as good returns as when given to calves or other animals.

Molasses. In Louisiana, mules were found to relish 8 to 10 pounds of molasses per day. Berns found that light horses could be maintained on 3 quarts of molasses and 15 pounds of cut hay per day. Molasses was also given in feeds of 1 quart diluted in 3 quarts of water to heavy horses at hard work. Berns concludes that good molasses is a nutritious, easily digested food for horses and has a tendency to prevent digestive disturbances. A sudden change from oats to molasses mixed with other materials is quite safe, and economy in feeding may thereby be accomplished. In Porto Rico, Griffin found that 13 to 15 pounds of molasses and 35 pounds of grass constituted a maintenance ration for a horse weighing 1000 pounds.

Rations for Horses. The rations commonly fed to horses vary greatly in different parts of the country, according to the cheapness and abundance of different crops. In the Northern States the standard ration consists of oats and timothy hay; in the Southern States the prevailing ration is corn stover and corn, while on the Pacific Coast the common ration is barley and oat hay or wild oat hay. In other parts of the world still other rations are commonly fed, and the general results obtained from these different rations are about equally satisfactory. It is perfectly evident, therefore, that feeding horses is an art and not a science. After a horse raiser has acquired a certain amount of practical experience in feeding one ration, that ration in his hands gives satisfactory results. The same feeding materials might be given with unsatisfactory or disastrous results by other persons who have not had experience with those particular materials. No farmer in the Southern States would consider it practical to buy oats and timothy hay for feeding his horses simply because that ration was found satisfactory in the Northern States. There is no one ration for horses. A combination of suitable and economical feed stuffs should be made according to the abundance of the crop and prevailing market prices, and various substitutions may be made, as indicated in discussing the various feeds.

At the Utah Station corn meal and timothy did not sustain work horses as well as oats, wheat and clover hay as a summer ration. In winter the first or wide ration was equal to the second or narrow ration. In summer a narrow ration was found to be better for work horses than a wide ration. At the Utah Station a moderate grain ration was found to be more effective and economical than heavy ones. It is recommended that the proportion of grain be smaller in summer than in winter. At the New Hampshire Station experiments with 5 different rations showed that all were effective for work horses. Each ration had 10 pounds of hay per day; the other feeds were oats, corn bran, gluten feed, linseed oil meal and cottonseed meal. A ration containing gluten meal was satisfactory in every respect. The ration containing corn and oats was the most expensive. The corn and bran ration was the most relished by the horses and was moderate in cost. At the Maryland Station excellent results were obtained from mixed feed containing 50 parts new corn product, 10 parts hominy chop, 10 parts ground oats, 10 parts ground rye, 10 parts linseed meal, 5 parts gluten meal, 5 parts wheat bran. It was relished by the horses and gave greater gains than a ration of corn, oats and new corn product, or of corn, oats and timothy hay. The Maryland Station determined by experiment that an exclusive grain ration is not good for horses. They soon lose appetite and refuse to eat an exclusive oat diet.

Feeding and Care of the Foal. When the mare's milk is abundant no extra feed is required for the first few days. It is well, however, to accustom the young colts to feeds of grain as soon as possible. After a few weeks they may be safely given 2 or 3 quarts of oats per day with good results in weight. As indicated in the discussion of milk, this material may be given in as great quantities as will be taken without danger. It produces rapid gains and has great influence upon the form and spirit of the developing colt. Milk may be fed fresh or skimmed. Since mare's milk contains slightly more sugar than cow's milk, a small quantity of sugar may be added for the first few feeds, but it does not seem to be necessary.

Feeding Stallions, Mares, Road Horses, Work Horses. The rations for different classes of horses will naturally vary according to the purpose for which

they are fed, according to their age and according to the severity of work which they are performing. It is not necessary in this connection to indicate the numerous successful rations which have been devised for horses of different classes and for stallions and mares. Naturally stallions require a more extensive grain ration during the period of active service. Mares should be fed during the period of lactation on foods which will supply tissue forming substances and also produce an abundant flow of milk. Care should be taken not to feed substances which might disturb the digestive condition of the colt. It should always be remembered that the peculiar properties of feeding materials may readily be transmitted to young animals through the milk. In fact, disturbances may often be produced in the young, while the mother animal shows no effects of the particular feeding material.

The Order of Giving Hay, Grain and Water. In discussing drinking water for horses it has already been stated that water should be given at least 3 times per day to horses at rest, and much more frequently to horses while at work. The order in which hay, grain and water are to be given has led to extensive discussions and some experiments. Horses at work may safely be given small quantities of water at any time, whether they are greatly heated or not. Theoretically, the system of feeding should require that the horse be given water first, and that the grain be not given until after some of the hay has been digested. In practice, however, this is frequently impossible, since it would require a too long feeding period in the middle of the day. In general, horses should not be given large feeds of hay at noon if they are to be worked in the afternoon—in fact, the hay may well be entirely omitted in the middle of the day. The usual custom among horsemen, which is followed with perfect safety, is first to water the horse after stopping work at noon, and then give the grain ration after a few minutes. In general, it will be found necessary to feed grain before the hay, for the reason that the animals remain impatient until they receive their grain. The stomach of a horse is small, and since a feed of hay following upon the grain ration would necessarily force a large portion of the grain out of the stomach before digestion was complete, it is desirable to allow a considerable interval in the evening ration, between the grain feed and hay feed. In Utah, Merrill recommended watering both before and after feeding.

Fattening Horses for Market. Horses of any age bring a better price in a fat than in a poor condition. It is advisable therefore to feed a fattening ration for a liberal period before marketing the animals. Horses may be made to gain from 3 to 5 pounds per day for a period of 2 months by suitable rations which include soft feeds such as a mixture of barley, roots, corn meal and bran. Sugar beets may be mixed with barley of a No. 4 grade at the rate of 25 pounds to the bushel of barley. The whole should be boiled until quite soft. To every 3 pounds of this mixture 2 pounds corn meal and 2 quarts bran may be added and fed warm, mixed with an equal bulk of cut hay or straw. This is a good ration for a single animal. The horses should be gradually accustomed to linseed meal until 1 pound per day is fed. Give plenty of salt and water. Care should be exercised to prevent the horses from getting off feed or developing colic at the beginning of the fattening period.

Diseases:

MEDICINES. For an account of the medicines and of the doses mentioned under the dosages below *see Veterinary Medicines*.

GLANDERS is a malignant contagious disease due to the action of the glanders bacillus. The disease is most common in horses, asses and mules, but may occur in nearly all of the domestic animals except cattle. Man sometimes becomes infected through wounds. Glanders is almost uniformly fatal, but the course of the disease may vary from a few weeks to several years. Three forms of the disease occur, pulmonary, nasal and skin forms. In pulmonary glanders the lungs are the chief seat of infection and certain tubercles of different sizes, depending on their age. In nasal glanders the chief symptom is chronic catarrh. The discharge may be interrupted at intervals, but soon begins again. The skin form of glanders is called farcy, and the characteristic symptom is the presence of swellings in the lymphatic glands just beneath the skin of various parts of the body, especially on the hind legs. These farcy buttons may be accompanied by general swellings of affected parts.

Many of the symptoms may be absent in certain cases. In cases of recent origin or slow development, where the external symptoms are not well marked, mallein has been found a most valuable agent in

the detection of glanders. Mallein is a product of the glanders bacillus containing the active toxin or poison, but no living bacilli. It cannot produce glanders in healthy horses and does not have any noticeable effect upon them. In glanderous horses a hypodermic injection of mallein causes an elevation of temperature and certain other reactions.

There is no satisfactory medical treatment for glanders. Some experiments have indicated a curative action of repeated doses of mallein, alone or combined with creolin. Good care and a nutritious diet may enable glanderous horses to live for several years, but in the meantime they may spread the contagion. All glanderous animals should be killed immediately and burned or carefully buried.

Tetanus, or lockjaw, is a virulent disease characterized by permanent muscular contractions which are due to an intoxication of the nerve centers by the products of the tetanus bacillus. Nearly all the domestic animals are subject to the disease. It is most common in horses and mules and rare in cattle. Tetanus sometimes occurs in cows in abnormal parturition. The disease often arises from infection in the wound in operations such as castration, docking the tail, etc. A prominent symptom is the continued muscular spasm, which may be increased in severity by any fright. Different parts of the body are attacked in different cases. Sometimes the muscles and head and throat are chiefly affected, in other cases those of the neck and back or of one side. The general sensitiveness of the animal is increased and the slightest noise may produce fright. The head and tail are usually extended and the movements of the animal are stiff. A grating of the teeth is often observed.

The tetanus bacillus is common in floors of stables and in gardens, and wounds received in such situations may result in the development of tetanus. As a preventive treatment it is advisable to give proper antiseptic care to wounds. In the treatment of tetanus good results have been obtained by the use of antitetanus serum. This serum is prepared from the blood of horses recovered from tetanus, and produces immunity to tetanus in man and horses. In large doses it has given good results after the first symptoms of the disease have appeared. A veterinarian should be called to administer this treatment.

Cerebro-Spinal Meningitis is a non-contagious disease which occurs among horses in isolated case or occasionally in extended outbreaks. The disease is not well defined and probably several different infections have been referred to under this name. Similar, if not identical, diseases have been called grass staggers, choking distemper and blind staggers. Horses of all ages and both sexes are affected. Temperament and physical condition do not alter the susceptibility to the disease. Mules are also attacked and mortality among them is as great as among horses. According to some European authors, the disease is due to the presence of a micro-organism on the brain membranes. Similar conditions were found in a recent outbreak in Maryland. The disease has been attributed by different writers to ergot, smut and other fungi which are supposed to be taken with the food. In some instances improper feeding has been considered the cause of the disease.

The symptoms are staggering gait, partial or total inability to swallow, muscular contractions and delirium. In violent cases treatment is seldom successful, while in mild forms the administration of cathartics, tincture of aconite and blisters on the neck, spine and throat, give some relief.

Pneumonia in the horse may affect both lungs but usually attacks the right lung. The first symptom is usually a chill, after which the breathing becomes more rapid and the animal holds its head in a low position. There is considerable elevation of temperature, the pulse is frequent and hard or sometimes weak and irregular. A dry cough is noted at the beginning and occasionally there is a discharge from the nostrils which is somewhat colored with blood. Constipation is an almost constant symptom and the legs are cold. In treating pneumonia, good ventilation should be given without exposure to cold air or sudden changes of temperature. Plenty of cold drinking water should be given, the legs may be rubbed and bandaged after application of liniment. Considerable benefit may be derived from hot applications to the chest by means of woolen blankets. In some cases bleeding may be slightly beneficial, but it is not to be generally recommended. The use of aconite is also to be deprecated, especially if the pulse is somewhat weak. After evidences of fever are gone, a good laxative should be given, accompanied with tonics.

Influenza, also called pink eye, epi-

zooty, bilious fever, etc., is a contagious disease which causes alterations in the blood, general depression of the vital forces and often inflammation of the lungs, intestines and brain. One attack ordinarily renders the animal immune to the disease. Influenza develops within from 5 to 7 days after exposure to the disease. The first symptoms are fever and a general dejected condition of the animal. The hair is rough and the animal has frequent chills. The fetlock and under surface of the body may become excessively swollen. The temperature reaches the highest point within from 24 to 48 hours and remains nearly stationary for a period of 3 or 4 days. At the end of the course of the disease the fever abates rapidly and convalescence is prompt if no complications occur. The most common consequences of this disease are congestion of the lungs and pneumonia, inflammation of the brain, founder and pleurisy.

The administration of quinine and salicylic acid in dram doses will lower the temperature, and aconite will have a favorable action upon the heart and circulation. Iodid of potash is sometimes administered on account of its alterative action and the indirect effect upon the lowering of the temperature. In cases where the action of the heart is much weakened, digitalis and other stimulants should be administered.

STRANGLES, also called distemper or colt-ill, is an infectious disease of horses, asses and mules, most frequently observed in young animals. One attack of the disease confers immunity. The first symptoms are sluggishness, irregularity of the appetite, increase in thirst, a dry coat and a bright rose color in the mucous membranes of the eye and mouth. After a period of about 2 days, there is a discharge from the nose which at first is watery and later becomes thicker and bluish in color. Soon after this discharge is established, a swelling takes place underneath the head between the jaw bones. The swelling is puffy and hot and results in the formation of an abscess, from which a discharge takes place. In some cases the swelling under the jaw is excessive and the abscess requires lancing. Delirium, plunging and other involuntary movements are sometimes observed during the disease. Mild cases of strangles require little treatment beyond careful diet and protection from cold drafts. In cases where the fever is excessive, Galuber salts may be administred 3 times a day in large doses. Small doses of quinine, aconite or iodid of potash will assist in controlling the fever.

BOTFLY (*Gastrophilus intestinalis*) in the adult condition is a fly about ¾ of an inch long, with transparent wings bearing dark spots. The body is hairy, the head brown with a white front, and the body brown with 3 rows of black spots. The flies appear from June to October and lay their eggs on horses in a position where the animal can reach them by biting or licking. The eggs are thus taken into the mouth and reach the stomach. Here the larvae hatch and attach themselves to the stomach wall by hooks. They remain in the stomach until they attain full size, when they become detached and passing out with the excrement complete their transformation into flies in the ground. The administration of medicinal substances to destroy or expel bots is usually unsatisfactory. Some experiments indicate that bisulphid of carbon administered in small doses in capsules has a beneficial effect in expelling the bots. Horses should be thoroughly groomed, in order to remove or destroy the eggs and prevent their entering into the stomach.

SCREW WORM (*Compsomyia macellaria*) is somewhat larger than the common house fly, but resembles the latter in general appearance. The color is metallic green, with 3 black stripes on the back. The eyes are reddish and are very prominent. Eggs are laid in wounds or the natural openings of animals or man, and the grubs after hatching bore their way into the flesh, making a deep wound. Infested animals if untreated may die of blood poisoning. The worms should be removed and the wound treated with a solution of corrosive sublimate, turpentine, kerosene or crude carbolic acid. Tar, grease or fish oil on wounds will assist in keeping the flies away. The screw worm fly attacks almost all domestic animals, but is perhaps most harmful to cattle, although its attacks upon horses are very important.

BIGHEAD, also called osteoporosis, is a disease in which the bones become less compact by reason of an increase of the spaces filled with marrow and soft tissues. The enlargement of the head is usually the most conspicuous symptom and there are usually noticed a weakness in the back and a gradual change in the ribs, so that the horse becomes flat sided. Lameness appears suddenly and accompanies all the other processes of the disease. Horses, mules and perhaps other animals are af-

fected. Horses under 8 years of age are more susceptible than older ones. One attack of the disease does not confer immunity, but it is probable that an affected animal never recovers. Temporary improvement may be brought about in the animals condition by rest and administration of lime in drinking water.

TEETH of horses usually wear in an irregular manner by the constant grinding of their surfaces together, while the outer edge of the upper teeth and the inner edge of the lower teeth are not worn off at the same rate as the rest of the surface and project in the form of a cutting ridge. In such cases the sharp ridges may readily be felt by the hand and should be rasped off by means of a float, so as to prevent injuries to the cheeks and tongue. The indiscriminate floating and rasping of horses' teeth without definite reason is much to be deprecated.

SPASMODIC COLIC is the term applied to spasms of a portion of the small intestines. It is caused by copious drafts of cold water when the horse is warm, foreign bodies or indigestible food in the intestines. Other predisposing causes are usually assigned, such as the common observation that high-bred horses are more susceptible than coarse lymphatic animals. Spasmodic colic begins suddenly. The horses may look backward, stamp impatiently, paw the ground, suddenly lie down and get up again in a few moments. An interval of ease follows, but a sudden attack soon recurs, and as the disease progresses the attacks become more severe and the intervals between them shorter. When the pain becomes severe the animals throw themselves down and show convulsive movements which may result in serious injury. An effective remedy and one that is commonly used consists of 2 ounces of sulphuric ether and 2 ounces of laudanum in a half pint of linseed oil. Another, and perhaps equally effective remedy, is 1 ounce of chloral hydrate given as a drench in solution in water.

WIND COLIC is probably due to sudden changes of diet or to long periods of fasting, followed by a heavy feed. Indigestible or sour feed is also supposed to cause this affection. This form of colic does not develop so suddenly as spasmodic colic. The horse appears dull and an enlargement of the abdomen, difficult breathing, trembling and profuse perspiration are noted. A good remedy for this trouble is baking soda in doses of from 2 to 4 ounces. A cathartic should be administered when the symptoms are first manifested. Barbadoes aloes is perhaps the best for this purpose.

ROARING is a chronic affection which causes a loud peculiar noise in breathing. Roaring is caused by some obstruction in the air passages. The majority of cases of chronic roaring are due to paralysis of the muscles of the larynx, which is in turn supposed to be caused by nervous disease. Cases of long standing do not yield to medical treatment. If administered soon after the symptoms appear, a course of treatment with iodid of potash will give good results.

HEAVES is a disease about which a great difference of opinion prevails. The general symptoms consist in a peculiar movement of the flanks during breathing and a chronic cough. In the act of expelling the air from the lungs, it is noticed that the elasticity of the lungs is considerably weakened, and that the abdominal muscles are brought into play to assist the action of the lungs. Indigestion is nearly always observed in cases of heaves, and many veterinarians maintain that the cause of this disease is an affection of the pneumo-gastric nerve, which, as is well known, sends branches to the various vital organs. There is no satisfactory cure for long-standing cases. Proper regulation of the diet relieves the symptoms to some extent, and since the disease appears to be connected with digestive disturbances, especial attention should be devoted to the maintenance of a good ration. Some good effects have been noted from the use of arsenic in solution in hydrochloric acid. This solution may be obtained from any drug store and contains 4½ grains of arsenic in each ounce. A tablespoonful of this solution mixed with the feed 3 times daily, for a period of 2 weeks, prevents to some extent the development of the distressing symptoms of heaves.

SPLINTS are bony enlargements which occur between the hock and fetlock joints on the inside of the leg. They vary considerably in size in different horses. They appear most commonly on the fore legs. Splints frequently accompany lameness which is not a continuous condition, but becomes more pronounced after considerable exercise. Since splints are comparatively harmless, it is not desirable to interfere with remedial methods, unless they become an actual cause of lameness. Tincture of iodin may be applied to the inflamed portions several times each day.

and if this method is ineffective, resort may be had to Spanish fly blister.

Bone Spavin is an outgrowth of the hock joint. Enlargement usually appears on the front and inner side of the joint, but may sometimes occur on the upper part of the hock. In some cases there is no enlargement of the joint which may be detected by sight or touch. Such cases of spavin are due to a partial union of the bones which constitute the joint. This disease interferes in a very serious manner with the usefulness of the affected horse. Horses should be turned out to pasture at once and allowed to rest for not less than 1 month. Good results may be expected from local applications of astringents or liniments, such as iodin. Where such remedies fail to give the desired results, the part may be freely cauterized with a firing iron.

Founder or laminitis is an inflammation of the sensitive tissue of the feet, accompanied by general constiutional disturbances. As predisposing causes of this disease some writers assign plethoric condition, unusual excitement, and high calkings without corresponding toe pieces. The immediate causes of laminitis are usually blows upon the feet, overexertion, indigestible foods and the excessive use of purgatives. The first symptoms are congestion of the sensitive membranes of the foot, the pulse becomes accelerated, and the temperature rises. Respiration is also more rapid. The disease appears more often in the fore feet than in the hind ones. The acute cases run their course in from 10 days to 2 weeks or more, and the crisis in symptoms appears in from 3 to 5 days. In simple cases of laminitis the feet should first be placed in warm water and after a period of half an hour be placed into cold water. The feet should be kept in a dish of water at a temperature of 45° to 50° F., or should be wet with cold water every half hour if the horse is lying down. Aconite may be given for 2 hours in 10-drop doses in cases where the pulse is rapid and strong.

Fistula is a term applied to the pipes or tubes leading from cavities in the muscles to the surface of the body through which a constant discharge takes place. The pipes are lined by a false membrane and do not heal. Fistulae may occur on any part of the body, but are most common in the withers and on the poll. In the latter situation fistula is commonly known as poll-evil. Fistulous withers and poll evil are caused by blows or chafing from improperly fitting harness or saddle. The muscles at this point are so arranged that any pus that forms has a tendency to bury more deeply, rather than to make its way toward the surface, the result being a running sore in either case. If the trouble is noticed before the formation of pus has penetrated too deeply, the whole false membrane may be cut out by means of a sharp knife. In long standing cases, however, such operation requires too extensive cutting or might be dangerous. The treatment to be adopted in such cases consists in making an opening to the outside at a point slightly lower than the bottom of the pocket which contains pus. A free drainage to the outside is thus established and may be maintained by the use of a seton or string tied into the wound. The healing process may be facilitated by repeated washing of the cavity with rather strong solutions of antiseptic substances, such as corrosive sublimate or carbolic acid.

Wounds. The treatment of wounds in farm animals is a matter which receives little attention from the ordinary stock raiser. Various diseases, especially tetanus, may be contracted through fresh wounds, and there is always some danger of blood poisoning or septicaemia in such cases. The old notion that a healthy wound should discharge pus is a mistaken one. Where cut surfaces can be kept perfectly clean the wound heals without the formation of pus. Under ordinary circumstances this is impossible in wounds in farm animals. Whenever an animal receives a wound, however, an effort should be made to treat the wound so as at least to prevent the development of dangerous bacteria. For this purpose corrosive sublimate may be used as a wash at the rate of 1 part in 1000 parts of water. A 2 per cent solution of lysol, formaline or creoline may be used in treating wounds. Carbolic acid, 1 part to 100 parts of water, is much employed for the same purpose.

Where wounds are so situated that they cannot conveniently be kept covered with gauze or cloth, the use of iodoform or other dry antiseptic substance is highly recommended. Iodoform is especially valuable on account of its power of driving away flies.

Sarcoptic Scabies, or mange, in horses has been known in several of the Western States for 20 years or more. It is believed to have been introduced into Montana by the Nez Perce Indians in their raid in 1877. Horses may be treated for this disease by spraying or brushing with

zenoleum, chloronaphtholeum, or lime and sulphur dip. For applying these remeides it is necessary to rope range horses, and such application has already been made on many thousands of these horses.

Horse Shoeing. The use of iron shoes for horses' hoofs may be considered as a necessary evil of our modern civilization. It is impossible to drive horses continually over the hard pavements of cities without seriously injuring the hoofs unless some form of shoe is adopted. Horses which are kept on the farm or driven short distances along country roads do not require shoeing, except occasionally, and then often only on the front feet. The art of horse shoeing may be learned by the ordinary farmer so that he can keep his horses' feet in good condition, but if the farmer does not care to bother with this operation, it is at least desirable that he give enough attention to the matter to know when the job is properly done by the blacksmith. Too much cannot be said in condemnation of the practice of indiscriminate paring away of the hoof in order to make it fit the shoe. The hoof may in certain cases grow irregularly and require some paring, but none is needed if the growth is uniform and no tendency to cracking is observed. The normal hoof of the horse is well designed to protect the more delicate parts which it covers, and to furnish an elastic cushion to relieve the jar upon the joints of the legs. When too much of the hoof is pared away, the elasticity is lost, and the sole becomes too sensitive so that some form of lameness may develop. Lameness may also result from driving the nails too deeply into the horn of the hoof. A slight study of the structure of the horse's hoof will convince anyone that the frog and bars of the hoof should be left with as little interference as possible. It is merely necessary to rasp off the ragged edges of the toe and sides when these parts grow out so far as to incur danger of breaking. In order to insure the normal development of the hoof in colts it is desirable that they be allowed plenty of exercise out of doors, so that the wear on the hoof will be uniform.

It is sometimes thought that the shoe should be heavy in order to wear as long as possible. A light shoe, however, will often wear nearly as long as a heavy one, and for all practical purposes the lighter the shoe the better and the least likely it is to interfere with the gait of the horse. In summer and at all times when the roads are not slippery, no calks should be allowed on the shoes, but on icy roads in winter a permanent calk may be used, or one of the forms of "never slip" calks. A convenient calk of this sort is of a conical shape and furnished with threads by means of which it may be screwed into the shoe. Recently considerable success has been had with the use of a rubber pad between the bars of the shoe. This gives a large surface of contact and thus prevents slipping at the same time and an added elasticity is secured.

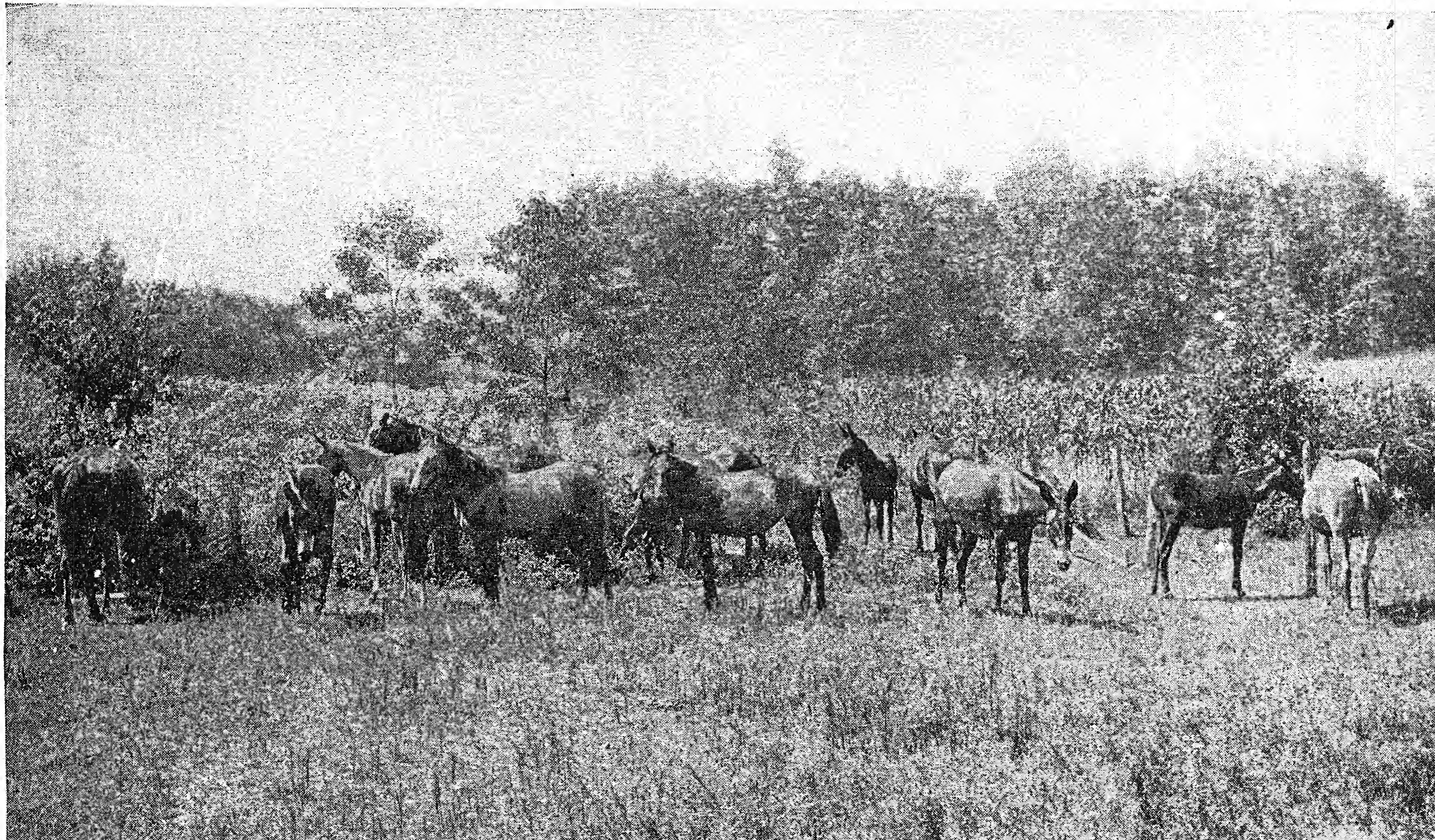
MULE

Crosses or hybrids have been produced between the horse and other members of the horse family, including the ass, the zebra and the quagga. Until quite recently, however, no great economic importance has attached to any of these crosses except the mule. The cross between the male zebra and the mare is known as zebroid, and the breeding of these crosses has been carried on in Brazil and elsewhere with considerable success. It is claimed for these hybrids that they are capable of as much work as the common mule and are more graceful and docile.

The common mule is a cross between the male ass and the mare. The cross between the stallion and the female jackass is known as hinny. This cross is smaller and less desirable in every respect than the mule. It has never attained much economic importance.

Various breeds of jacks are known and used for the purpose of breeding mules in this and other countries, such as the Catalonian, Andalusian, Majorca, Maltese, Italian and Poitou.

The native jack is as a rule heavier and larger boned than the imported species. It is presumably the result of a mixture of all the imported breeds and possesses all of the colors belonging to these breeds. As a rule mule breeders in this country prefer native jacks to all of the imported breeds. The colts obtained from native jacks are stronger and with more length. The size and color of native jacks in the country vary exceedingly, according to the mixture of breeds from which they have descended and the care in selection which has been exercised by breeders, black with white points preferred. In the Western States the common form of jack in the mountainous regions is known as burro, and this breed is presumably descended from stock originally brought into the country by Spanish settlers of that region. This animal varies in color

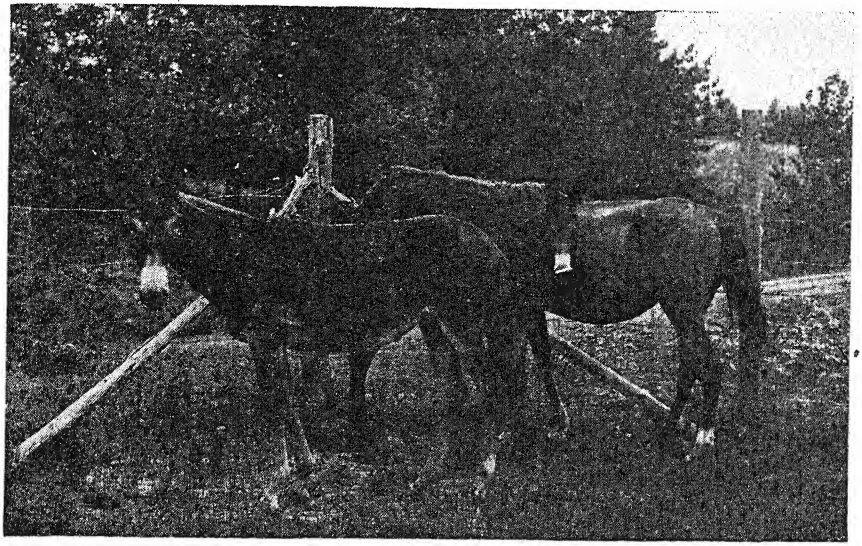


A MULE BREEDING HERD

from white to almost black and varies also considerably in size, and especially in the thickness of the base of the neck.

The mule industry in the United States is of great importance and received especial impetus following the Spanish-American and South African Wars, and as a result of the gasoline shortage of 1942. The States in which the largest numbers are bred are Texas, Mississippi, Georgia, North Carolina, Tennessee, Alabama, and in general the Southern and Central States. According to the latest census there are at present 3,811,000 mules and 110,000 jacks and burros in the United States. The market prices of mules are uniformly higher than those for horses, and as a result of these conditions the raising of mules under favorable conditions is a very profitable industry.

Mules may be used for all purposes for which horses are suited, and in addition are well adapted to several lines of work in which horses cannot be employed. Mules excel horses in their capacity for hard labor, in endurance, in length of life, in freedom from disease and in economy of feeding. In an emergency mules may be worked for 24 hours or more without water and for 2 or 3 days without feed. The injurious results of such treatment are much less serious than in the case of horses. Digestive disturbances are less frequent in mules than in horses, and in general, with the possible exception of glanders, mules are comparatively less subject to disease than horses. Mules are especially adapted for use in mining, and as beasts of burden for packing purposes. For the latter purpose, also, the jack and Western burro are especially adapted. These animals, though diminutive in size as compared with the horse, will carry as much weight, and as far in a day, as horses. They are, moreover, sure footed, and can carry packs with safety where accidents would be almost inevitable with horses. The economy of feeding mules makes their employment in sugar and cotton raising almost universal, in fact, it may be doubted, under present conditions, whether these industries would be possible if all the labor which is now done by mules had to be performed by horses. In the Southern States 2 types of mules have received special names on account of their connection with these industries. The sugar mule is larger, more powerful and more valuable than the cotton mule, which is the smaller, cheaper type. These types are governed according to the requirements placed upon the animal, the work in the sugar field being harder than that in the cotton field.



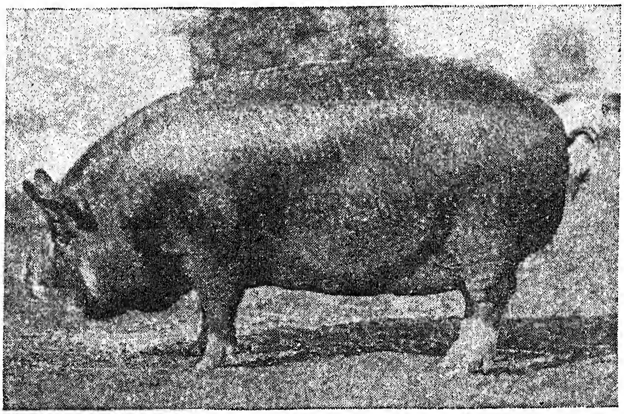
MARE AND MULE COLTS

As draft animals and for general work purposes mules excel horses in several respects. They are capable of more continuous application at heavy work under unfavorable conditions. Although they may often be less tractable, they are also

less excitable and therefore more desirable for work in situations where unsteady movements or plunging would be dangerous to the draft animals and to the machinery and attendants. The color which is most desired in mules is dark brown or black, and in breeding them the jacks and the mares are selected with reference to the probability of securing these colors in the mules. It is usually considered that the female mule is more desirable than the male.

Mules require essentially the same general care and management as horses. They should be weaned at about 4 months of age, and the subsequent feeding should be governed according to the purpose for which the mules are being raised. The market requirements for mules are that they shall be fat, and attention should therefore be given to this point in order to bring them to a fat condition soon after they are 2 years of age. In the Southern States it is well to begin the fattening process in November before the animals become 2 years old. They may be fed a dozen ears of corn per day and an abundance of clover or timothy hay, until the following April. The mules may then be turned out upon clover pasture and the quantity of grain may be increased. As soon as the clover is cut feeding with clover hay may be resumed in the barn, and shelled corn should be continued in the ration. When barley is harvested it should be ground coarsely and fed in fresh condition, taking care that it does not sour. At this time the ears of early corn may be fed, while a highly nutritious diet should be continued, consisting of corn in the ear, shelled corn, ground barley, oats and bran. The animals should have free access to water and salt. Shelled oats and bran are regarded by many mule raisers as essential to the proper finishing of mules for market. With sugar mules this process of feeding should bring the animals to a weight of from 1200 to 1350 pounds when they are just past 2 years old. The same care and attention should be given to the feeding of cotton mules, except that the process should begin later, usually after the animals are past the second year.

Experiments have shown that ground Kafir corn and Kafir corn stover constitute an excellent feed for mules. In one experiment mules were kept in good condition by feeding on Kafir corn stover for about 6 months, and on alfalfa and prairie hay for the remainder of the year. In comparative experiments with mules and horses it was found that the mules did about ⅓ more work than the horses, ate less corn, more stover and required more water. Bermuda grass hay and timothy are of about equal value in feeding mules. It is stated by J. L. Jones that as the result of experiments extending over a period of 25 years, 3 mules may be expected to consume about as much feed as 2 horses, and to remain in better condition than the horses, although doing the same amount of work. For further details on feeding *see* under *Horses.*

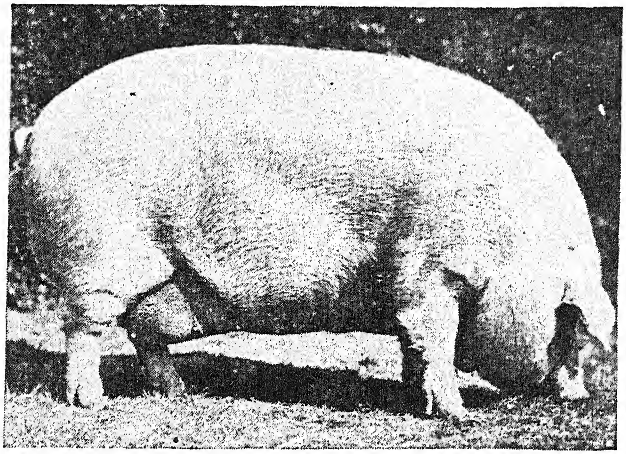


BERKSHIRE BOAR

SWINE

Swine in the United States are grown primarily for pork and lard and there is no fixed market for any other type. In Canada bacon hogs are grown to a con-

siderable extent for the English market, the Tamworth breed being chiefly used for this purpose. The packers once offered a premium for hogs fattened on a ration containing peas, wheat, screenings and skimmilk as well as corn, in an attempt to secure a lean, firm bacon for the English market. But the response from farmers was very slight. Some of the long-bodied breeds grown in this country are also used in the production of bacon, but they are first of all lard hogs. Some of the chief characteristics of the principal breeds of hogs grown in the United States may be briefly mentioned as follows:



CHESTER WHITE SOW

Berkshire. The Berkshire is a black hog with white feet, white line in the face and white splashes on the end of the tail, with occasional white spots on other portions of the body. Ears erect. The sows are prolific and active. Good shoats weigh 240 to 300 pounds at 9 to 12 months of age and mature hogs 500 to 650. They are fine boned and on this account more subject to broken legs in shipping than the larger boned breeds. A very popular breed in the South.

Poland-China. The Poland-Chinas are black and white spotted hogs weighing 250 pounds and upward at 9 to 12 months and 600 to 700 pounds when mature. They have large hams, short, strong legs, are excellent shippers and the most generally popular breed grown by Western farmers.

Duroc-Jersey. The Duroc-Jersey is a red-haired hog. Otherwise they much resemble the Poland-Chinas. Well-matured shoats weigh 250 to 340 pounds when 9 to 12 months old and 400 to 700 pounds at maturity. They are quiet hogs, excellent feeders, stand forcing well and never sunscald. The bones are large and the sows very prolific.

Chester Whites. Chester Whites are solid white. The hogs dress 175 to 250 pounds when 8 or 9 months old and weigh when mature 600 to 700 pounds. They sunscald easily in the South, but are popular farther north and in the East. The sows are prolific but apt to be cross at pigging time.

Cheshire hogs are white with small erect ears. They have long, broad, deep bodies, broad hams and nearly straight back. At maturity they will dress from 400 to 600 pounds if well fattened.

Yorkshire. The small Yorkshires are pure white hogs with pink skin, ears erect. These hogs will weigh when mature 375 to 450 pounds. They have a short, rounded, deep body, well covered with hair, and will do as well in the South as any of the white breeds, but cannot compete with the black-haired hog. The large Yorskhires weigh up to 800 pounds when mature.

The **Essex** is another small to medium-sized hog. It is a black hog with compact body and weighs 250 to 400 pounds at maturity. It fattens readily, is not affected by sunscald and is especially valuable in the South. Where corn is abundant the Essex cannot compete with the larger breeds.

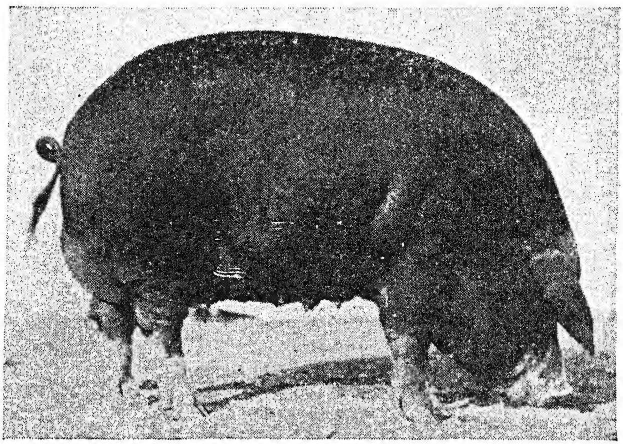
The **Tamworth** is one of the oldest and purest of swine breeds. They are long-bodied hogs, and when grown for bacon

are usually sold when they weigh 160 to 225 pounds at 6 to 9 months of age. The Tamworth and Yorkshire are bacon type, all other breeds are lard type.

Tests of Breeds. In the station experiments with breeds, better results in gains have been made with pure breeds in Iowa, Kansas and Utah than with scrubs. At the Ottawa Station cross bred and grade hogs made better gains than pure breeds. At the New York State Station the most profitable gains were made with a Yorkshire-Tamworth cross. The Berkshires have made 100 pounds of gain with less food at 5 stations than any other breed tested. At 2 other stations they were surpassed by a number of breeds. At the Ottawa Station a Tamworth-Berkshire cross made leaner, better meat than pure Berkshires. The Tamworth and Yorkshire are the breeds most prized for bacon by the Ontario Station. In tests at the Maine Station no constant differences occurred in the feeding or market qualities of the different breeds. The Iowa Station has shown that the Tamworth furnishes a carcass most in demand by the British market, followed by Berkshires, Duroc-Jerseys, Chester Whites, Poland-Chinas and Yorkshires, mentioned in the decreasing order of their desirability.

Best Breeds to Raise. The station experiments as a whole indicate that there are no constant differences in the feeding qualities of the various breeds of hogs now grown in the United States. Other things being equal, it is probable that the best breeds of pigs for the American farmer to grow are the largest ones. Nothing has been more clearly demonstrated in the station experiments than that pigs increase in weight most rapidly, require less food to make a pound of gain and make gains most cheaply during the early stages of growth. As pigs approach maturity it costs 3 to 4 times as much to make a pound of gain as in the earlier stages of growth. Tests of gaining in weight by cross-bred and pure-bred hogs show no great differences in rate.

Hogs most in demand in the great packing centers are those weighing from 225 to 325 pounds each when 8 to 14 months old. If breeds of hogs weighing 500 to 800 pounds when mature are selected, and these marketed when they have reached weights of 200 to 300 pounds, the chances are that the grower has produced his pork at the most economical figures. Management and feed are more important than any particular breed.



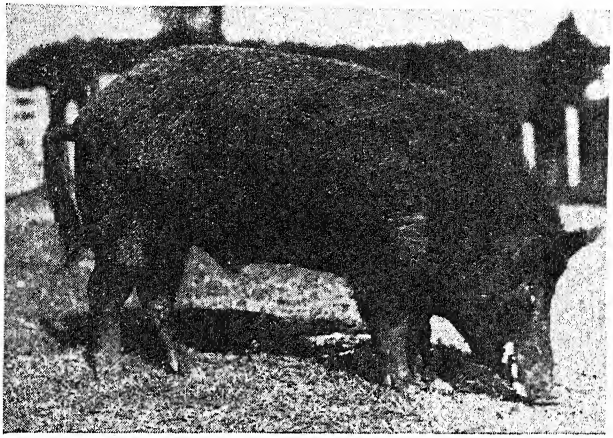
POLAND CHINA BOAR

Boar and His Management. The boar is generally considered half the herd. He should contain the best characteristics of the breed to which he belongs. He should have a strong constitution, good feeding capacity, relatively short neck and short legs, since these indicate good fattening qualities, and a close, compactly built body. Of course, boars for fancy breeding purposes, where color, form and markings must conform closely to the ideal, will cost much more than the common run. But good breeders frequently sell boars slightly off in markings at little more than their pork value. Such

animals may often be used very profitably where pork and not show is wanted. The boar should be kept in a lot by himself and be given plenty of good clover, or like kind of pasture, and such other foods as middlings, oats, peas, bran, etc. He should not be fed so heavily as to become fat and unwieldly. Boars give their best service when 2 to 5 years old, but boars 8 to 9 months old may be satisfactorily used for breeding old sows.

Sow and Her Management. Young sows, or sows in poor condition, carry their pigs about 16 weeks and old sows 1 or 2 weeks longer. With 8 breeds at the Wisconsin Station the litters ranged from 6 to 10 pigs each and weighed from 13.5 to 22.5 pounds. The pigs at birth weighed from 1.3 to 3.1 pounds each. Analyses at the same station of different samples of sows' milk showed an average of 8.24 per cent fat, 6.04 per cent casein and albuminoids, 4.75 per cent milk sugar and 1.07 per cent ash. The quantity yielded varied from 4.1 to 5.8 pounds per day, and in one instance reached 8.7 pounds. Sows should not be bred before they are 8 months old. They should be allowed to suckle their pigs for 2 months to 10 weeks and be so managed as to produce 2 litters a year. Good breeding sows should be kept as long as they produce large litters and prove good mothers. This is usually 4 to 5 years. When they fail in either of these respects they should be fattened for meat.

Pregnant sows should be allowed to run in a lot containing plenty of green feed. They require in addition such liberal allowances of muscle, bone and milk making foods as shorts, ground peas and oats, bran, etc., as will keep them in good condition. Corn is fattening and is not suitable for pregnant sows except in small amounts when fed with milk or such grains as noted above. About a week before farrowing the sow should be separated from the other hogs and put in a pen by herself with a very small amount of bedding. The pen should have a 10 or 12 inch plank running around the sides of it 6 to 8 inches above the floor as a protection for the young pigs so that the sow cannot crush or smother them. A constant supply of ashes and salt should be kept within reach of the sow and should she appear costive at this time she should be given a good feed of wheat bran. At farrowing time she should be fed nothing but water or thin slop for the first 24 hours and only very lightly for several days. At the end of a week the ration should be rapidly increased and should consist of such milk producing foods as shorts, bran, ground peas, milk, etc. From now on while the sow is giving suck to her pigs, she should be fed heavily. The Wisconsin Station found it profitable to feed suckling sows so heavily that they gained in weight. The gain thus produced in the young pigs indirectly through the sow, was cheap and more economical than later gains.



TAMWORTH BOAR

The U.S. Department of Agriculture recently compared hand feeding and self feeding of sows and pigs: "The general plan of self feeding was to supply certain feeds in the self-feeders which were con-

stantly accessible both to the sows and their pigs. The sows and pigs in the hand-fed lot were given twice daily all they could readily eat. Close observation of the sows and pigs during the time these tests were carried on indicated that both sows and pigs on the self-feeders looked better and were more thrifty than the sows and pigs in the hand-fed lot. A noticeable fact about the sows in the self-fed lot was that there never was any crowding at the feeders. Scarcely ever were there more than 2 or 3 sows eating at the same time, even when a dozen or more sows were being fed from one feeder. Only a small quantity would be consumed at one time. It was taken slowly and apparently thoroughly masticated and digested.

"When hogs of any age have constant access to self-feeders there is practically no danger of their overeating at any time. This is a valuable factor in the use of self-feeders for sows which are suckling their litters.

"The system followed in weaning the pigs was simple and apparently very satisfactory, especially in the self-fed lot. The plan in these lots was to put a fence around the self-feeders 3 or 4 days before the sows were to be taken away, leaving openings large enough so that the pigs might continue to have access to the feeds whenever they desired. Because the feed was shut off from the sows the milk flow was naturally reduced and the pigs soon forgot their mothers and depended entirely on the feeds from the feeder. In no case were there any noticeable ill effects among the pigs that were weaned by this system, nor did udder trouble develop in the sows."

Some farmers, however, feed the sows and pigs separately by the creep system. Skimmilk or a thin porridge of middlings is most relished at this time. As soon as they begin to eat freely they should be crowded with feed, since the most economical gains in the life of the pigs are made at this time. At the Wisconsin Station sows and pigs before weaning required 316 pounds of corn meal to make 100 pounds of gain, while the pigs alone after weaning required 384 pounds of meal for 100 pounds of gain.

When the young pigs are about a month or 6 weeks old all the males intended for pork should be castrated. If this operation is done while the pigs are still sucking the sow there will be practically no check in growth, if it is neglected then the operation should be postponed for a month after weaning, or until they become accustomed to eating solid food. After weaning the sows will come into heat again in 2 or 3 weeks and should be bred again. In one test at the Kansas Station gains were cheaper and greater in offspring of mature sows, in another test no difference was noted.

Pasturing Hogs. Young growing pigs should have plenty of green pasture, pure water and grain. The old method of allowing pigs to grow for a year on pasture or on wood lots without other feed is expensive and not now practiced by those who make a success in growing hogs for pork. Pigs should be so fed as to gain in weight from ½ pound to a pound a day from the time they are 3 weeks old until they are marketed. On pasture alone hogs make too slow gains for profit and cannot be brought to a marketable condition. Pigs at pasture, however, make the best use of the grain fed to them, as shown by experiments at a number of stations. On a full grain ration pigs at pasture made 33 per cent better gains at the Utah Station than pigs without green feed. Cutting the green feed and feeding it to pigs in confinement did not give as satisfactory results as pasturing. At the Maryland Station there was more profit from pigs running in pasture or woods in summer and penned up for fattening 8 to 10 weeks before killing time than from pigs kept penned up during the summer. The pigs that had been at pasture made faster and cheaper gains, were more vigorous and had better appetites than those kept penned up. In Ontario firmer bacon was produced with exercise than in close confinement. At the Utah Station more feed was consumed and the gains were more rapid with pigs given exercise than with those kept in close confinement.

Some of the best green feeds for hogs are alfalfa, clover, rape, cowpeas, peanuts, artichokes and sweet potatoes. Hogs are wasteful grazers and the fields of pasture crops should be arranged with movable fences in such a manner that the hogs can pasture only on a small portion at a time. A succession of crops should be grown so that the hogs will have continuous pasture throughout the season.

The Arkansas Station recommends red clover, sorghum and peanuts as the best succession for grazing hogs in that State. Alfalfa may replace the red clover. Hogs grazed on these crops made rapid and economic gains on small grain rations. Oats and rye were not profitable for a hog pasture at this station.

SANITARY WATERING TROUGH FOR HOGS

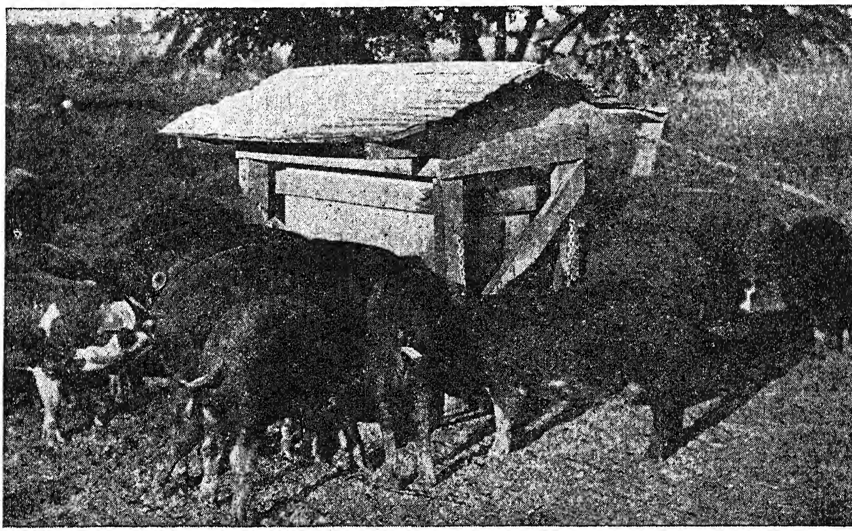
At the Kansas Station 1 acre of alfalfa pasture produced 776 pounds of pork. Alfalfa proved inferior to sugar beets at the Montana Station but saved grain as a part ration.

Brome Grass pasture was greatly relished by hogs and gave good returns at the Ottawa Station.

Dwarf Essex Rape grown in the same manner as for sheep (*see Rape*) has proved an especially valuable crop for pasturing hogs at the Wisconsin Station and has also given good results when cut and fed green. The rape was greatly relished by hogs after they learned to eat it, but was not sufficient as an exclusive ration. In one experiment at the Wisconsin Station 1 acre of rape proved equal in feeding value to 3318 pounds of grain (corn and shorts), in another test to 2767 pounds, and in a third test to 2436 pounds. This crop is considered the best green feed tried at that station for pigs 4 to 10 months old. It saved 33 pounds more grain per 100 pounds of gain than clover and the pigs fattened on it were thriftier and had better appetites than when fed grain alone. The crop does not cause bloating or scouring if properly fed.

Sorghum and Kafir Corn are among the best green crops for early summer grazing for the Southern and Western States, and if planted at intervals will furnish forage until late fall. The sorghum may be grazed as soon as it has reached 5 or 6 inches in height. The Kafir corn is of more value later in the fall after the heads have matured.

Cowpeas furnish valuable forage from July to September in the North and still later farther South. Chufas are grown to some extent for hogs. At the Arkansas Station firm, fat pork was produced on chufas, but it was not equal to that produced from corn. At the Alabama Station an acre of chufas produced about 374 pounds of pork and were fully equal to Spanish peanuts as a pasture for hogs. Purslane is often fed to hogs. They made fair gains on this plant when fed in connection with a grain ration at the rate of 9 pounds per day, but did not greatly relish it.



SELF FEEDER FOR HOGS

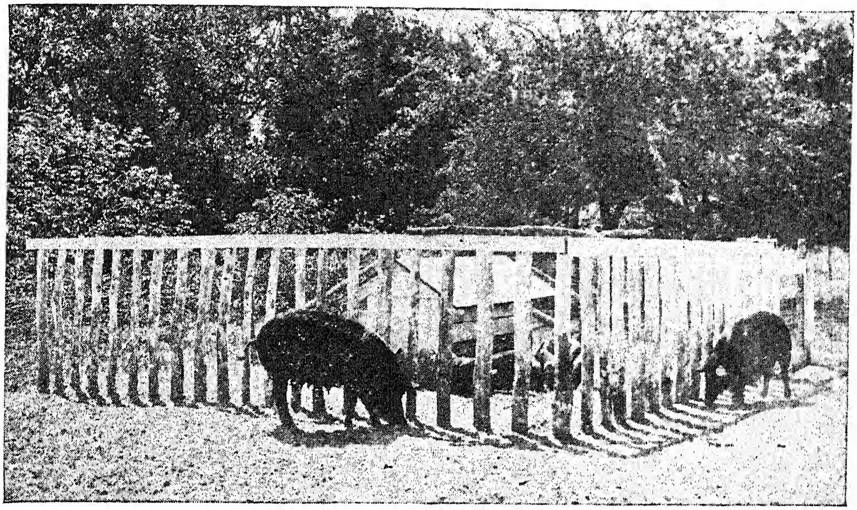
Artichokes are excellent as a green feed for hogs in early spring and late fall and are greatly relished by them. The hogs root out the tubers themselves. At the Ottawa Station pigs on artichokes made rapid gains when given only a small grain ration ($1\frac{1}{2}$ pounds mixed meal per day). Both the Arkansas and Maryland Stations have found artichokes profitable in pig raising. In Missouri 1 bushel of artichokes and 3 bushels of corn proved superior to 4 bushels of corn for hogs, and very similar results are reported from the Oregon Station. For the culture of artichokes *see Artichokes*.

Sweet Potatoes make a good root crop for hogs in the South, especially on light

soils. They may be had from September to November and the hogs do their own harvesting. At the South Carolina Station it required 32½ pounds of sweet potatoes to make 1 pound of gain. In Arkansas hogs in a field of sweet potatoes at the station did not take to them readily and did not make satisfactory gains. The Alabama College Station found 3 pounds of sweet potatoes inferior to a pound of corn meal for hogs. The crop was of considerable value at the Maryland Station when fed in connection with gluten meal and milk. Like other succulent food, sweet potatoes, to be valuable for hogs, must be fed in connection with a grain ration.

Early Feeding. Hogs never make such rapid and economical gains as when they are young. Feeding with skimmilk, kitchen slops and grain should therefore commence as soon as the pigs can be induced to eat these different foods and continued until the pigs are marketed. At first the more nitrogenous foods like skimmilk, shorts, ground oats, ground peas and barley should be fed, and later more carbonaceous rations given. Feeding in early life should be for the purpose of developing the bones, muscles and vital organs of the pigs. This gives a foundation for more profitable forcing later. In feeding experiments at the Utah Station young hogs on grain alone made poor use of their food. Much better results were obtained when milk was added. Some corn may be fed to growing hogs on pasture, providing they have an abundant supply of other nitrogenous foods or access to wood ashes, bone meal and salt.

Ashes and Salt for Pigs. An abundant, supply of wood ashes and salt, to which the hogs can have constant access, is an essential in hog raising and should never be neglected. In experiments at the Wisconsin Station when either hard wood ashes or bone meal was fed to hogs the strength of the bones was about doubled and there was a saving of 28 per cent in the amount of food required to make a pound of gain. The addition of the bone meal or wood ashes to the daily ration caused the consumption of more salt, water and corn meal. Either charcoal or ground bone may be substituted for wood ashes. Hogs are never injured by eating all the ashes they want and they are especially necessary when highly carbonaceous rations like corn are fed. In experience at the New York State Station better gains were made on all rations when a small amount of salt was added. Large quantities of salt should not be fed since they may reduce the gains. The salt and good hard wood ashes should be mixed in about the proportion of 2 quarts of salt to a bushel of ashes. Sometimes a few ounces of copperas are added to this mixture, which acts as a kind of tonic. This mixture should be kept in a low box under shelter to which the hogs have access at all times. Brood sows which have



CREEP FOR FEEDING YOUNG PIGS

an abundance of such material with their daily rations seldom eat their young.

Sows vs. Barrows for Fattening. At the Utah Station where this matter was tested about the same gains were made by both. The gains by the sows were slightly greater. In Denmark no constant difference was found in the fattening qualities of sows and barrows. Unspayed sows at the Utah Station made slightly better gains than spayed sows. At the Indiana Station the period of heat (oestrum) in the sow had no apparent effect on gains.

Shelter for Hogs. Comfortable sleeping quarters should be provided for hogs and shelter from the scorching sun, cold rains and snow. The sheds need not be expensive. Hogs required more feed for maintenance when fed in the open air at the Utah Station, but made more economical gains.

Hogs Following Steers. When steers are fattened for market a considerable percentage of the grain given them, especially if unground, passes through the intestines undigested. Experiments at several stations, and the general practice of feeders, show that hogs following steers require much less feed to make a pound of gain than otherwise. Hogs made good gains on corn obtained in the droppings of corn-fed steers at the Wisconsin Station, and it is recommended that steers be fed unhusked shock corn and hogs be allowed to run with them. Hogs did better when the steers were fed dry corn than when fed soaked corn. When cattle were fed corn meal at the Iowa Station hogs made little gains following them. Hogs at the Kansas Station made equally good gains on manure of steers fed on Kafir corn.

Cooked vs. Uncooked Feed. At the Wisconsin Station hogs made cheaper gains on uncooked corn and shorts than on cooked. The cooked corn was not properly masticated. A considerable loss was noted in the feeding value of barley meal, corn meal and shorts by cooking. In the station tests 439 pounds of uncooked corn meal equaled 454 pounds of cooked meal. On rations of peas, barley and rye the Ottawa Station found a slight advantage in favor of steaming, but not enough to pay for the extra labor. All these experiments tend to show that it is not necessary or advantageous to cook feeds for hogs. These remarks do not apply to roots, more especially potatoes. At the Ottawa Station cooked roots have given better results with hogs than raw roots.

Whole vs. Ground Grain. Experiments at the Vermont and Wisconsin Stations indicate that strong, vigorous hogs do not require that corn be ground. It may be ground and fed in the latter stages of the fattening period, especially with hogs not in the most vigorous condition. In some cases there is an apparent loss in the feeding value from grinding. Pigs eat more corn meal than whole corn and therefore usually make more rapid gains, but experiments at the New Hampshire, Vermont, Wisconsin, West Virginia and Colorado Stations show that the increased gains are not sufficient to pay for the extra cost of grinding. At the Wisconsin Station 8 per cent better gains were made on corn meal than on whole corn. At the New York State Station 16 per cent cheaper gains were made on corn meal than on whole corn.

Wet vs. Dry Feed. The data reported by the experiment stations on this subject are somewhat conflicting, but in general they tend to show that soaking has about the same effect upon grains as grinding and is desirable. At the Illinois Station pigs ate more and gained more on soaked corn than on dry corn. The Ottawa Station recommends soaking all grains whether ground or whole, for 24 to 30 hours before feeding. At the Wisconsin Station hogs ate more and did better on wet than on dry feed. Wet corn meal was more satisfactory for feeding to pigs at the Vermont Station than dry meal. In West Virginia 385 pounds of soaked corn equaled 410 pounds of dry corn meal. At the Ontario Station dry and wet mixed was of equal feeding value, but more of the meal was wasted when fed dry than when fed wet.

Relation Between Weight of Hogs, Gain Made and Food Required. I have already spoken of the more profitable gains made by feeding young growing pigs. The figures, based on so many experiments and animals that they may be considered very reliable, bring the fact out clearly that it requires about ⅔ more food to produce 100 pounds of gain with hogs weighing about 300 pounds than with hogs weighing 40 pounds, and that there is a uniform increase in the amount of food to produce a pound of gain as the pigs increase in weight. Experiments at the Wisconsin Station show that a maintenance ration for hogs amounts to about 1 per cent of the live weight of the animals when middlings are fed. Small pigs

require relatively smaller amounts of feed for maintenance than large hogs.

Grains and By-Products for Fattening Pigs. Under this heading the value of the different grains, mill products, tankage, sugar and like feeds used in producing pork, will be noted alphabetically.

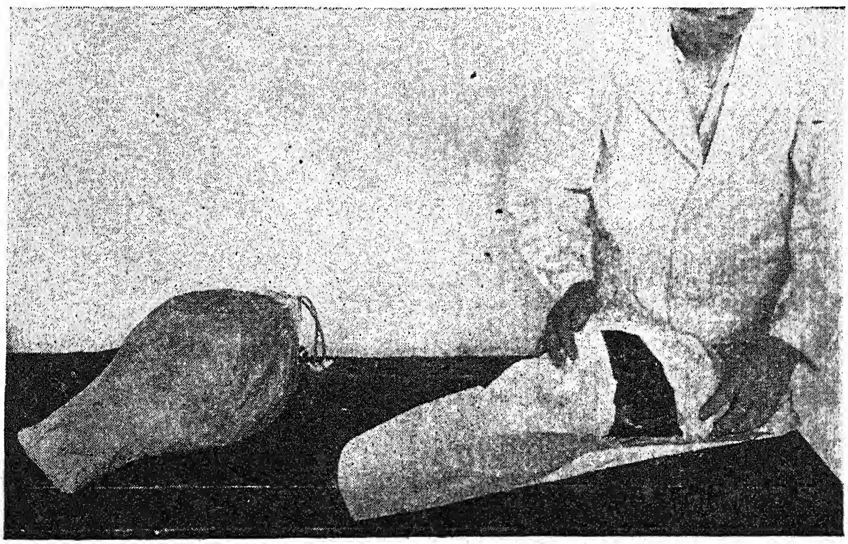
ACORNS. Hogs are often fall pastured in oak woods on acorns. At the Tuskeegee Agricultural School of Alabama acorns gave a desirable flavor to the meat. The meat produced was soft and did not harden readily except when corn was fed with it. The acorns had a tendency to produce constipation. Acorns may be successfully kept in large quantities by collecting and placing in cool, well-ventilated barrels.

BARLEY. This grain is especially valuable for growing hogs and in the production of firm bacon. At the Ottawa Station large hogs required 4⅔ pounds of grain per pound of gain. When fed whole ⅛ of the grain passed through the intestines undigested. As an exclusive grain ration barley gave good gains and made exceptionally fine bacon at the Ontario Station. When fed grain alone better gains were made on barley at that station than when mixed with other grains. At the Colorado Station barley equaled corn for growth and fattening. Bald barley was slightly better than common barley. With ground bald barley 3.6 pounds were required to produce a pound of gain. Both ground bald and ground common barley proved equal to corn meal.

With hogs 14 months old at the Wisconsin Station 36 pounds more barley meal was required to make 100 pounds of gain than of corn meal. The same difference was noted when skimmilk was added to both rations. Hogs fed on barley meal drank more water. On the whole barley meal was found a very good and satisfactory grain ration for hogs by this station, but it was not equal to corn for fattening purposes. Pigs relished barley meal most when soaked in at least 3 pounds of water to each pound of meal. Barley is an exceptionally safe and valuable feed for pigs whether fed alone or in combination with other feeds.

BRAN. This feed was found undesirable for pigs by the New Hampshire Station whether fed alone or with corn meal. Its value was slightly improved by fermentation. Bran is a valuable feed for breeding stock, but is unsuited for young stock, and when fed to fattening pigs only limited amounts should be used.

BUCKWHEAT. In experiments at Ottawa it required 4.45 pounds of ground and soaked buckwheat to produce 1 pound of gain, and 4.10 pounds of wheat to produce a pound of gain in the same trials. The percentage of dressed to live weight was greater in buckwheat-fed than in wheat-fed hogs. Hogs at this station fed exclusively on buckwheat produced soft lard and soft sides in some cases, but

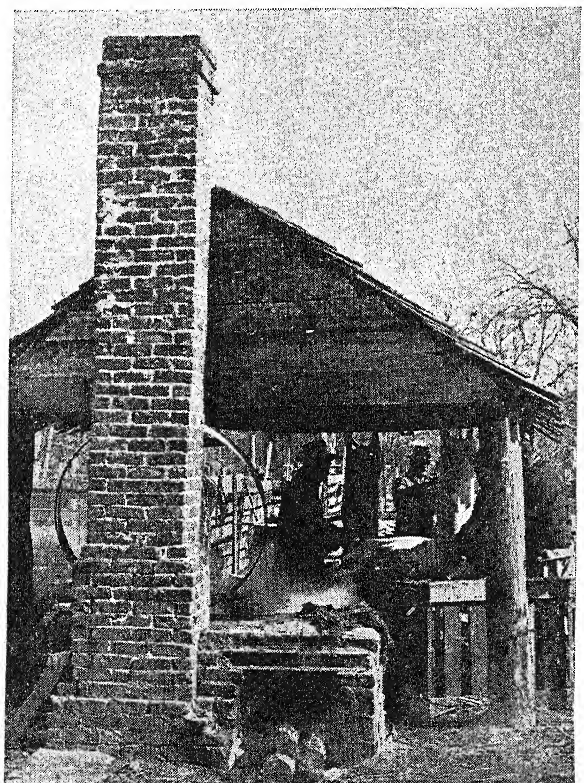


WRAPPING HAMS FOR STORAGE

not uniformly. These tests show that buckwheat has a high feeding value for hogs, but is not quite equal to wheat.

CORN. Corn is the cheapest and usually the most satisfactory grain fed to hogs in the United States. It is the best of all grains for finishing off hogs, but should not be fed exclusively to young growing pigs or to the breeding stock. Experiments with this grain at the Wisconsin Station show that corn-fed hogs contain more fat and less water, and the skeleton, skin and internal organs weigh less than in hogs receiving a mixed ration. Hogs will live a long time and make good gains on an exclusive corn diet. At the Ontario Station corn produced no bad effects on the quality of bacon when used in finishing hogs which had had exercise or some milk. When fed for long periods it appeared to make the bacon soft. In experiments at the Arkansas Station harder lard was produced on corn than on soy beans, chufas or peanuts. A large number of tests have shown that on the average a bushel of 56 pounds of corn will produce 10 to 12 pounds of pork. At the Iowa Station 1 bushel made 17 pounds of pork and 3½ to 5 pounds were required to produce a pound of pork at the Washington Station.

The relative merits of ground and whole corn are discussed under *Whole vs. Ground Grains* above. Generally corn need not be ground for hogs. Though a little better gains are made on the ground grains they are made at a greater cost. At the Wisconsin Station corn meal proved cheapest as an exclusive ration, although more was required than when a ration was fed containing corn meal and peas or corn meal and dried blood. Corn is the standard grain for fattening hogs. Other grains are fed but largely as substitutes when corn cannot be easily obtained. Its value in pork production cannot be overestimated.



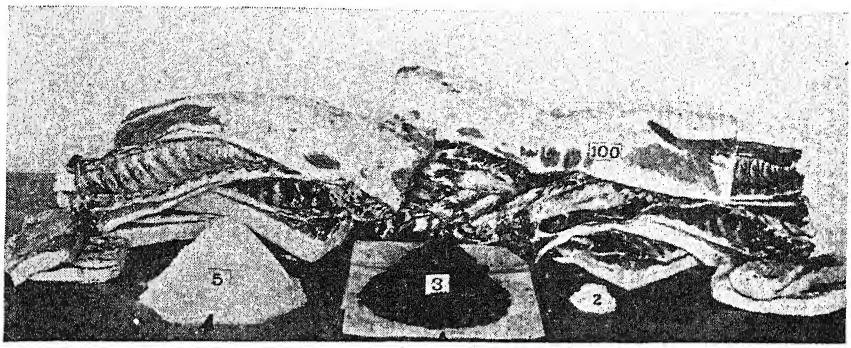
HOME BUTCHERING HOUSE

COWPEAS. Pigs on cowpeas and corn

at the Alabama College Station made much greater gains than when fed on corn alone and there was more lean meat produced than when corn only was fed. In one experiment at the South Carolina Station it required 4.91 pounds and in another 4.43 pounds of cowpeas to produce a pound of pork. At the Alabama College Station it required 4.81 pounds of cowpeas for a pound of pork. On cowpea pasture pigs made good gains at the Maryland Station. Cowpeas are rich in protein. They are therefore especially valuable for growing pigs.

meal, produced cheaper and better gains than corn or Kafir corn alone or mixed. That station recommends that not more than ⅕ of the grain ration fed to hogs should consist of cottonseed meal, and that a rather light grain ration be fed.

The gist of the matter from the standpoint of the feeder would seem to be that the status of cottonseed meal as a hog feed has not yet been definitely determined, and until this has been settled by careful experiments, it is better to let it alone or feed it in small amounts varying from ⅕ to 1/10 of the grain ration, and



DRY CURE FOR 100 LBS. BACON AND LOINS
SALT 5 LBS., BROWN SUGAR 3 LBS., SALTPETER 2 OZ.

Cottonseed Meal. According to the Texas Station cottonseed meal is not relished by hogs and is not profitable to feed in any form or under any conditions. It kills hogs when fed very long, though the danger may be slightly lessened by boiling. As a part grain feed it proved better than linseed meal at the Wisconsin Station, pigs on linseed meal requiring 24 pounds more feed for 100 pounds gain than pigs receiving cottonseed meal. Cottonseed meal, both cooked and raw, gave very unsatisfactory results at the Mississippi Station and caused the death of some of the hogs. The Alabama College Station states that feeding cottonseed meal as part of the grain ration beyond 34 days to shoats weighing from 59 to 118 pounds usually had a poisonous effect. The younger pigs were more seriously affected than the older ones. Death or sickness was caused when ⅕ to ¼ of the grain ration was cottonseed meal, even where green foods were given in abundance.

In experiments at the Oklahoma Station cottonseed meal when fed carefully with ⅘ grain ration of Kafir corn meal or corn

then for only short periods at a time. There is no doubt but what it is a very valuable feed when properly handled.

Distillery Grains. Dried distillery grains proved a very unprofitable feed for pigs at the Kentucky Station except in small proportions. Fairly good returns were secured when it constituted about ⅕ of the ration.

Fish Meal has given excellent results in fattening hogs in Ohio and New Jersey.

Kafir Corn. This has proved a very valuable grain for hogs in Kansas and Oklahoma and some other sections. At the Kansas Station 5½ pounds of Kafir corn equaled 4½ pounds of corn for hogs. It required 6.2 pounds of Kafir corn to produce 1 pound of gain. Hogs will not eat Kafir corn as long as corn. When soy beans and skimmilk were added to Kafir corn it made a much more relished and complete ration. Losses occurred when the grains were ground or soaked before feeding.

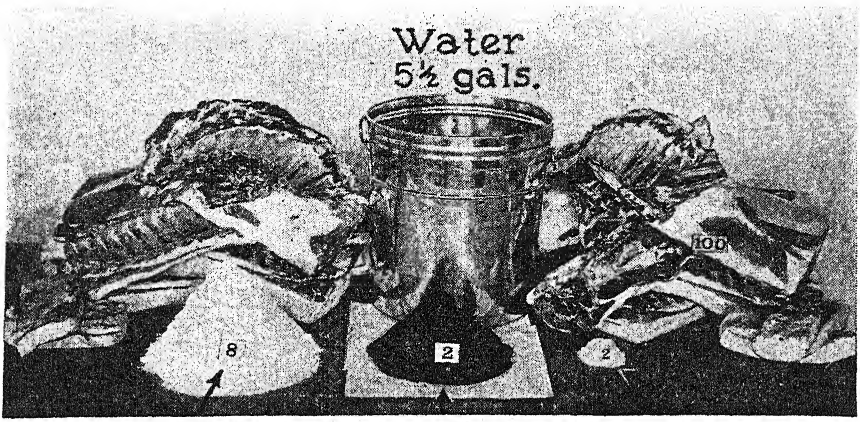
Linseed Meal. This meal should be fed with other grains and not alone. According to the Minnesota Station it is easily digested but not a profitable feed

for pigs over 100 pounds in weight. At the Maryland Station linseed meal gave better results than gluten meal for a short time, but later in the experiment the gluten meal produced more rapid and cheaper gains.

OATS. Oats fed to hogs at the Utah Station gave fat and meat of excellent appearance and firmer than that from any other grain. Larger gains were also made on oats than on any other grain. At the Wisconsin Station better results were secured when oats were ground than when fed whole. The best gains were made when the ration contained ⅓ ground oats and ⅔ corn meal. When fed whole at the Ottawa Station 1/7 of the grain passed through the intestines undigested. As a continued exclusive ration oats caused a loss of appetite and small gains at the Minnesota Station. At the Massachusetts Station 100 pounds corn meal proved equal to 120 pounds oat feed. Oats may profitably form a part of the grain ration fed to hogs. They are especially desirable for growing hogs and are more effective ground than when fed whole.

PEANUTS made soft and oily fat at the Alabama Station, but the meat had a good flavor. At the Arkansas Station hogs on peanuts made almost as good gains as on corn. The hogs were allowed to root out the peanuts and made rapid gains on them. At the Alabama College Station it required 2.8 pounds of unhulled Spanish peanuts per pound of gain. They proved superior to corn meal in one test. In another test hogs made 281 pounds of pork on peanut pasture alone and 333 pounds when a small grain ration additional was fed. Peanuts alone are not an adequate ration but the addition of salt and lime completed the ration as shown in experiments in Florida.

PEAS. Ground Canada field peas were found more valuable for pork production at the Wisconsin Station than corn meal. Corn, however, was so much cheaper than peas that it was the more profitably fed. The thigh bones of pigs fed on peas were 20 per cent stronger than in cornfed pigs. Peas should be fed to young growing pigs and breeding hogs in order to secure increased vitality. Peas mixed with bran half and half at the Utah Station were far superior to corn, barley or wheat mixed in the same manner. As an exclusive grain ration pea meal made unthrifty animals and poor gains and it is recommended that peas be always fed with some other feed. Peas contain large amounts of protein and are therefore of especial value for young hogs and the production of lean meat. They should always be fed either ground or soaked and preferably with corn meal or some other light feed.



BRINE CURE FOR BACON AND LOINS
SALT 8 LBS., BROWN SUGAR 2 LBS., SALTPETER 2 OZ.

PIGEON-GRASS SEED. Ground pigeon-grass seed was about equal to wheat meal for hogs at the Wisconsin Station. When ground cooked pigeon-grass seed replaced ⅔ of the corn meal in the ration, there was a saving of 13 pounds of the total ration required to produce 100 pounds of gain. Hogs did not relish pigeon-grass seed alone but ate it readily when fed with corn.

RICE MEAL. At the Vermont Station

rice meal produced 23 per cent less gain with pigs than corn meal. When fed with milk at the South Carolina Station it had a feeding value equal to that of corn meal. A pound of gain was produced on 2.48 pounds of rice meal and 10 pounds of skimmilk. At the Massachusetts Station rice meal produced as good gains as corn meal in pigs weighing 60 pounds at the beginning of the test and 190 at the end.

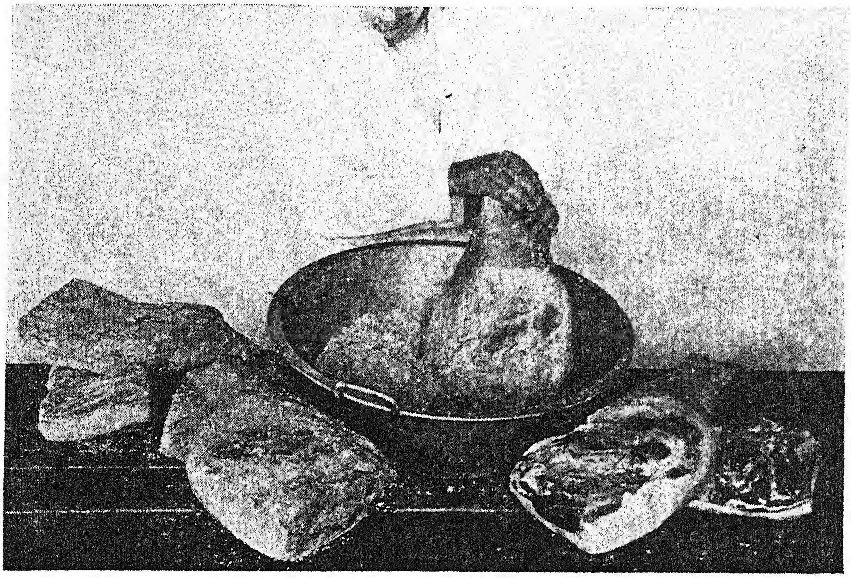
RYE. This grain has proved about equal to barley for pork production in feeding tests with 110 animals. According to the Massachusetts Station rye meal fed for a long time causes loss of appetite and digestive troubles and should be combined with wheat meal or corn meal. In Danish experiments also rye shorts produced low gains and had an unfavorable effect on the quality and softness of the pork.

SORGHUM SYRUP SKIMMINGS. This material was found more than capable of maintaining pigs at the Wisconsin Station. It is recommended that it be fed with corn meal or other feeds.

SORGHUM SEED MEAL was found by the Wisconsin Station to have 55 per cent of the feeding value of corn meal. Sorghum silage proved a poor food for hogs at the Tennessee Station.

SOY BEANS. At the Kansas Station soy beans ground and mixed with corn or Kafir corn made a saving of from 13 to 37 per cent over feeding corn or Kafir corn alone. That station recommends that they be fed whole mixed with other grains. There was a loss from grinding. At the Arkansas Station soy beans produced as firm fat as corn, but the fat was not equal to corn fat in other respects. Soy beans 1 part and corn 2 parts proved an excellent feed for pigs at the Kentucky Station.

SUNFLOWER SEED. These were readily eaten by pigs at the Ottawa Station, but their feeding value was not determined.



APPLYING DRY CURE TO HAMS

SUGAR AND SUGAR BEET MOLASSES. Sugar added to a mixed ration has given very unsatisfactory results in feeding experiments. It was not equal to starch and hindered the formation of muscle and fat. Molasses from a beet sugar factory proved a very unsatisfactory food as a part ration for pigs at the New York Cornell Station. In some Norwegian experiments 1 pound of molasses was found equal to ¾ pounds of corn.

TANKAGE. This consists of the ground refuse meat of slaughter houses. It is used as a fertilizer and contains large amounts of nitrogen and phosphoric acid. When fed to pigs at the Indiana Station in the proportion of 1 part ground tankage to 5 and 10 parts corn and corn meal respectively, it proved extremely beneficial in growth of pigs as well as financial

returns. With ½ part tankage, ½ part shorts and 10 parts corn meal, equally good results were also obtained. In all cases cheaper and better gains were made when the tankage was added to the ration than when corn was fed alone. The results indicate a high value for tankage and similar feeds as supplemental feeds with corn for the production of pork.

Wheat. Wheat meal at the Wisconsin Station was not quite so valuable in producing gains as corn meal, but a mixture of the two in equal parts was better than either alone. In later tests ground wheat proved equal to corn meal. Wheat should not be fed whole, either dry or soaked, but should be ground, moistened and mixed with corn meal. At the Indiana Station it cost 3 times as much to produce a pound of pork with wheat as with corn.

In experiments at the South Dakota Station more rapid gains and a better quality of meat were produced on ground than on whole wheat. Meat from ground wheat was equal to that from corn and superior to that from peas or mixed feeds. It is stated that wheat can profitably be fed as the entire grain ration, but it is better to mix it with other feeds. At the Ottawa Station it required 4.1 pounds of soaked wheat to produce 1 pound of gain. Wheat has been profitably fed to hogs in Montana and Washington. It proved slightly superior to barley in Danish experiments. When fed with skimmilk at the rate of 3 to 6 ounces per quart it gave better results than rye meal at the Massachusetts Station.

At the Montana Station frozen wheat proved equal in feeding value for hogs to a mixture of wheat, barley and peas. The frozen wheat, even if subsequently heated by fermentation, was profitably and safely fed, 1 pound of the frozen wheat proved equal in feeding value to 7.9 pounds of skimmilk.

Dairy Products. Skimmilk, buttermilk and whey are of great value in all stages of hog raising. At the Wisconsin Station the weights of the kidneys and livers of pigs were increased by the use of milk in the ration. Milk is easily digested and adds to the development of muscles and strength of bones. In experiments at the Ontario Station all dairy products had a good effect in making firm meat.

Buttermilk. Most of the station experiments indicate that buttermilk is not quite equal to skimmilk for hogs. In experiments at the Wisconsin Station buttermilk was found to be worth 28 cents per 100 pounds for hogs when sweet skimmilk was worth 35 cents per 100 pounds. In other experiments sweet skimmilk had a value of 20.6 cents per 100 pounds when buttermilk was worth but 14.7 cents for pig feeding. At the Vermont Station buttermilk had ⅘ the feeding value of skimmilk for pigs. Buttermilk proved superior to skimmilk at the North Carolina Station.

Skim and Separator Milk. When skimmilk was fed as an exclusive ration at the Utah Station the pigs made slow gains and frequently lost appetite. The best ratio was found to be 3 pounds of skimmilk to 1 pound of grain. In this proportion it proved an excellent feed, especially for young pigs. Fed with grain the skimmilk had 75 per cent greater value than when fed alone. The gain in hogs fed on milk and grain was 2.54 times greater than on milk alone and 1.7 times greater than on grain alone. In experiments at the Wisconsin Station 462 pounds of separator milk saved 100 pounds of meal when fed in the proportion of 3 pounds of milk to 1 pound of meal. The Maryland Station states in this connection that skimmilk is worth more for hogs than the price usually charged for it at creameries. The Wisconsin Station recommends the use of 1½ pounds of skimmilk to 1 pound of corn meal as the most economical method of using milk. With pigs 3 months old that station found that 19 pounds of sweet skimmilk was equal to 4 pounds of corn meal for growth.

The Ottawa Station states that the greater part of the ration for growing pigs may be skimmilk. That station found that 6.65 pounds of skimmilk was equal to a 1-pound mixture of peas, barley and rye, and that 8.8 pounds equaled a like mixture of peas, wheat and rye. For fattening the station states that not more than 5 pounds per 100 pounds live weight per day should be fed. Hogs receiving skimmilk were more vigorous than those on grain alone.

Sour skimmilk has given better results at both the Vermont and Ontario Station than sweet skimmilk, but contrary results are reported from England.

In experiments at the New York Cornell Station extending over a period of 5 years the most economical proportions of skimmilk to grain have varied from 2.5 to 10.4 pounds of skimmilk to 1 of grain. Corn has been found the best supplementary grain to feed with milk. That

station concludes as the result of their work that the proportion of corn to skimmilk may be varied without apparently affecting the results, but in no case should the amount of skimmilk fed be greater than the pigs will quickly consume.

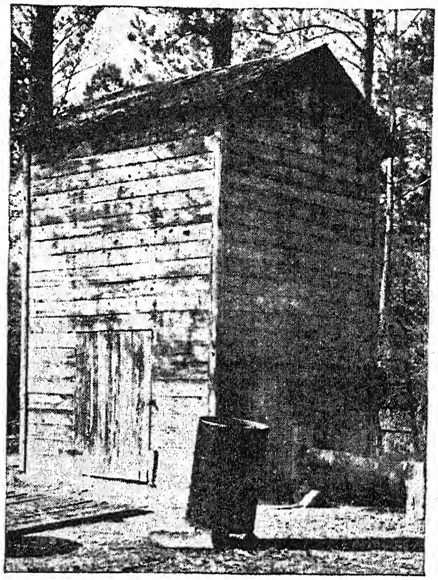
WHEY. Sweet whey has been fed to pigs experimentally at the Wisconsin Station. The pigs could not be maintained on whey alone, but when the whey was added to a mixture of corn meal and shorts it produced a marked saving when used in the proportion of 2 of whey to 1 of grain, or 10 of whey to 1 of grain. The use of 760 pounds of whey saved 100 pounds of grain in the ration for pigs. It is recommended that shorts, pea meal and oil meal be mixed with the whey for growing animals. At the Ontario Station 100 pounds of whey was equal to 13.3 pounds of mixed meal. Sour whey proved equal to sweet whey, there being no apparent loss from fermentation.

Forage, Roots, Silage, etc., for Hogs. Under this heading the value of various forage crops, roots, silage and fruits for hogs will be noted alphabetically. Their value as forage plants is also treated above under *Pasturing Hogs,* and that section should be consulted in connection with the various crops here mentioned.

ALFALFA. In experiments at the Utah Station alfalfa, either pastured or cut and fed green, was barely sufficient for maintenance. A loss in weight is reported from the Nevada Station when alfalfa hay alone was fed to hogs. The Montana Station reports that alfalfa is inferior to sugar beets for hogs, but saves grain as a part ration. As a supplementary feed with bran and grain the Utah Station reports profitable returns from alfalfa in winter feeding. Alfalfa hay with Kafir corn gave excellent results with hogs at the Kansas Station. One acre of alfalfa pasture at that station produced 776 pounds of pork. (*See Pasturing Hogs* above.) These tests indicate that grain should be fed with alfalfa in order to secure the best returns. The Nebraska Station reports that the thigh bones of pigs fed alfalfa chaff (mostly leaves) with corn were about 65 per cent stronger than the thigh bones of hogs fed corn alone.

APPLES. These have been fed experimentally to hogs at the New Hampshire Station. Even at 10 cents a bushel they were not an economical pig feed. Apple pomace when too much fermented was not relished by hogs at the Illinois Station. Some practical experience favors its use as profitable.

CLOVER. Much more economical gains were made by pigs on clover pasture than in pens at the Ottawa Station, and this is the general experience of feeders. As a part of the ration for fattening hogs clover equaled 1/10 of a mixed grain meal ration. Cut clover hay added to a corn ration at the Iowa Station added nothing to the feeding value of the ration. When clover hay is fed to hogs it should be cut and steamed. It adds bulk to grain rations and tends to keep the animals in good condition in winter feeding.



FARM SMOKE HOUSE

CORN FODDER AND SILAGE. Corn fodder chopped or the new corn product (*see* under *Corn*) proved valuable and profitable when fed to hogs at the Maryland Station.

The New York State Station states that corn silage cannot be profitably fed to hogs, they do not eat it clean, and it makes the cost of pork production too great. It was not relished by hogs at the Ontario Station. The hogs gained less rapidly when part of the grain ration was replaced by corn silage, and a financial loss resulted when half the mixed meal ration was replaced by corn silage. The Virginia Station found silage economical when fed with corn in a maintenance ration, but not so if used alone. At the Utah Station silage proved inferior to dried fodder corn. Silage in small

amounts was found useful at the Kentucky Station in fattening hogs. It tends to keep the animals in a good thrifty condition, but could not be substituted as a part of the grain ration. Pea and rape silage have both been fed at a loss to hogs at the Canadian Stations. These experiments indicate that silage is not a profitable food for hogs.

Cowpea Hay added to a ration of corn and Kafir corn made a great saving in the latter at the Oklahoma Station. At the Tennessee Station it proved difficult to get hogs to eat cut cowpea hay.

Grapes. In California hogs are sometimes allowed to harvest the second crop of grapes with profit in gain.

Mangel-Wurzels. As much grain was required to produce a given gain when mangel-wurzels were fed at the Indiana Station as when not fed. They had no apparent feeding value. The Utah Station states that hogs make smaller gains on roots than do cattle or sheep. At the Ottawa Station 6 pounds of cooked roots equaled 1 pound of mixed grains. Tests at the Canada Experimental Farms give mangels a lower feeding value than either sugar beets or turnips.

Pea Silage cut with green pods was not relished by hogs at the Ottawa Station and did not seem to have much feeding value. Hogs lost weight on an exclusive ration of pea silage.

Potatoes. At the Wisconsin Station 443 pounds of cooked potatoes equaled 100 pounds of corn meal for fattening hogs. One bushel of corn proved equal to 4½ bushels of potatoes. That station believes that potatoes should be cooked before feeding. The Minnesota Station found that potatoes were no more digestible when cooked than when fed raw, but that pigs ate more cooked potatoes than raw ones. At the Ottawa Station potatoes either raw or cooked were unsatisfactory rations for hogs. Even when fed with skimmilk, grain had to be added. Potatoes should be cooked for hogs and fed with grain for the most satisfactory results.

Pumpkins were better cooked than raw for hogs at the Ottawa Station, and hogs made exceedingly economical gains on rations containing pumpkins. At the Indiana Station pigs ate 26 pounds per day, made good gains and the meat was firm. The New Hampshire Station notes that in their experiments the feeding value of pumpkins was not increased by cooking. They should be fed raw mixed with corn meal. Pigs made good gains on cooked pumpkins at the Oregon Station when supplemented with a small amount of bran.

Sugar Beets. These roots gave good returns when fed with grain in feeding tests at the Utah Station. They proved superior to either turnips or mangels at the Ottawa Station. At the Indiana Station the cost of gain was 27 cents more per 100 pounds in hogs fed sugar beets than in those fed grain only. Tests at the Montana Station indicate that sugar beets added to grain rations for hogs save grain, promote digestion and improve the quality of the meat. In recent experiments at the Colorado Station the feeding value of either sugar beets or sugar beet pulp did not exceed $1.50 per ton. These feeds proved valuable chiefly on account of their mechanical effects. The station states that grass will answer this purpose as well and is cheaper. Not more than 2 pounds of beets or pulp should be fed to each pound of grain.

Turnips at the Ontario Station were not found profitable when replacing ½ mixed meal ration. They were inferior to corn silage. At the Nevada Station small gains were made on turnips and alfalfa fed together.

Rations for Hogs. Hogs generally consume less food and make the most rapid gains when they are fed on mixed rations. The following table brings out this point as regards the grains. It is compiled from about 75 experiments made with more than 500 animals:

Grain Required For 100 Pounds Gain

Corn	Kafir corn	Oats	Peas	Wheat	Barley	Mixed grain
lbs. 485	lbs. 529	lbs. 472	lbs. 439	lbs. 452	lbs. 418	lbs. 412

It will be noticed that it requires less mixed grains to produce 100 pounds of gain than when any single grain is used.

Exclusive grain rations for pigs are not economical. They should be fed as mixed and varied a ration as possible that will produce growth and fat. The effectiveness of corn meal was greatly increased at the Maine Station by adding pea meal or gluten meal, both during growth and during the fattening period. Young hogs on grain alone made poor use of their food at the Utah Station. Much better results were obtained by adding milk. Hogs fed on cassava, wheat middlings and cowpeas made gains at ½ the cost of gains made on corn alone at the Florida Station. Screenings and shelled corn produced pork at a good profit at the Minnesota Station.

Relative to narrow rations (*see Feeding Farm Animals*) the Virginia Station states that in their experiments narrow rations were not fed with economy and may be injurious to health. At the Vermont Station narrow rations caused more rapid gains and greater weight than rations containing more bulky feeds. The profits were greater from a ration containing moderate quantities of skimmilk than from rations containing large amounts of skimmilk. For finishing off, the station recommends 10 to 12 quarts skimmilk daily with all the corn meal that the pigs will eat. In Massachusetts wide rations gave slightly better results than narrow rations. The cost of gains on a narrow ration was slightly greater than on a wide ration at the Iowa Station. With pigs as with other animals plenty of nitrogenous foods should be fed while the animals are young and growing. These conduce to a healthy growth of all the internal organs, bones and muscles. During the fattening period more carbonaceous rations like corn should be fed. They are cheaper and generally produce more rapid gains.

Effect of Rations on Internal Organs, Fat, Lean, etc. The Wisconsin Station found that the feeding of an exclusive corn ration produced an excessive development of fat in and outside of the muscles. The muscles were of small size, the hair scanty and the skin thin. The brain, heart and lungs were not changed in size, but the liver, spleen and kidneys were much reduced in size. The amount of blood was much reduced, and the strength of the bones diminished 50 per cent as compared with hogs fed a highly nitrogenous diet.

Hogs fed on equal parts of corn meal and rye meal at the same station ate more feed and made more rapid and profitable gains than hogs fed ⅓ pea meal and ⅔ wheat shorts. The carbonaceous ration in the first instance was not only cheaper, but the percentage of dressed to live weight was greater in the corn-and-rye-fed hogs than on the more nitrogenous ration. On the other hand the vital organs were smaller in the corn-and-rye-fed hogs, and their vitality was therefore less. Another lot of pigs fed 13 weeks on shorts and bran, followed by 6 weeks of corn feeding, made more rapid and economical gains and showed larger livers and a larger proportion of muscle to fat than hogs fed the entire 19 weeks on corn. Corn-fed pigs in another test were not so smooth and had less hair than pigs fed on peas and shorts. The percentage of dressed meat to live weight was slightly larger in corn-fed pigs, but the weight of nearly all the internal organs was greater in pea-fed than in corn-fed hogs. At the Minnesota Station it was found that the form of the skull depended on nutrition, health and the use of the muscles of head and neck. Wild hogs that root extensively have long, narrow heads. The length of the intestines in domesticated hogs is about 2½ times that in wild hogs, and apparently still increasing. This makes possible the digestion and assimilation of large quantities of feeds.

Feeding for Quality of Meat. Corn meal made white, firm meat at the Kansas Station, while a mixture of shorts and bran made a soft, dirty-yellow meat. At the Virginia Station there was no difference in the proportion of fat to lean meat in pigs fed corn meal alone and those fed corn meal, beef scraps and bran. At the Wisconsin Station shorts produced the darkest meat, milk the next and corn the lightest meat. Wheat, corn and a mixture of both produced meat of like quality at the Indiana Station. At the New York Cornell Station meat scraps and corn meal produced the largest proportion of lean meat. In other tests at the same station there was no difference in hogs fed nitrogenous or carbonaceous rations. In still other experiments the proportion of lean meat was slightly increased by a nitrogenous ration.

In an investigation of the soft pork problem by the Canadian Stations corn in large quantities was found to produce a soft pork, while oats, peas, barley and especially skimmilk made firm pork. The size of the rations did not affect firmness. Cooked or soaked feed had no superiority over dry feed in producing firm bacon. Rape, pumpkins, artichokes, sugar beets,

turnips or mangels did not affect firmness.

Firm meat was secured by feeding mixed meal (barley, peas and oats) at the Ottawa Station. Corn meal and pea meal both had the effect of producing firm pork. The corn meal was rather the better of the two for this purpose. Buckwheat made soft meat. English experimenters recommend barley meal, potatoes and milk for firm, lean bacon. Barley in experiments reported from England made leaner meat than corn. Pasturing hogs on peanuts at the Arkansas Station also resulted in soft pork and a lard that melted at a temperature of 87.6° F. as compared with 114° F. for hogs on corn. The use of skimmilk or whey in the ration practically insures firm pork or bacon.

What the Experiments Show:

That all breeds are about equally valuable for pork production.

Growing pigs require nitrogenous foods like milk and such grain rations as shorts, ground peas, oats and barley.

Exercise and pasture are essential for the most economical production of pork.

Ashes fed regularly to hogs increase the strength of the bones about 50 per cent.

Hogs may profitably follow steers.

Cooking feed for pigs is unnecessary with the exception of roots.

The increased gains made on ground grains are not generally sufficient to pay for the extra cost of grinding.

Soaked grains can be more economically fed than dry grains. Generally soaking is equivalent to grinding.

Hogs gain most rapidly and can be fattened more economically before they have reached maturity.

Corn is the most effective grain in finishing off hogs.

Shorts, acorns, peanuts and buckwheat tend to produce soft lard and meat.

Exclusive corn rations in the early stages of growth reduce the size of the muscles, spleen and kidneys, diminish the strength of the bones about 50 per cent and reduce the quantity of blood.

Mixed grain rations are more economical and give better results than one kind of grain only.

Diseases:

Medicines. For an account of the medicines and of the doses mentioned under the diseases below *see Veterinary Medicine.*

Hog Cholera is an infectious malignant disease due to the action of a filterable virus in the blood, tissues of the body and in the intestines. The most prominent symptoms are loss of appetite, fever, discharge from the eyes, purplish coloring of the skin and constipation followed by a profuse diarrhea, which persists until death. Affected animals usually show a rise of temperature 1° to 3° above the normal, but this symptom is frequently absent. Sick hogs are dull and lie quietly in a corner or huddled together, usually hiding the head under the bedding. A slight cough is often noted. The discharge from the eyes is watery at first, but later becomes thick and yellowish. The gait is staggering and uncertain and the animals have a gaunt appearance, with arched back. The mortality from hog cholera ranges from 80 to 90 per cent. In acute attacks the animals may die within a few days, while in chronic cases the disease may extend through a month or more. The spleen becomes enlarged and soft. The large intestines may show slight hemorrhages. In the chronic form the intestines become ulcerated. In some cases, however, a general congestion and reddening of the whole mucous lining of the large intestines takes place.

There is no satisfactory medicinal remedy for hog cholera. All pigs should be immunized by virus-serum while sucklings by a regular veterinarian. When an outbreak occurs all healthy animals should be removed from the sick and exposed hogs, and should not be allowed access to the same food or water supply. The carcasses of dead animals should be burned or buried and infected pens should be thoroughly cleaned or burned. Animals from suspected localities should be quarantined until all suspicion has passed.

There are at least three infectious swine diseases of a malignant nature, hog cholera, swine plague and swine erysipelas. In the majority of outbreaks the first 2 of these diseases occur simultaneously. (*See Swine Plague.*) The distribution of the 2 diseases is about the same, but hog cholera is perhaps the most common.

Experiments have shown conclusively that a perfect disinfection of pens after an outbreak of hog cholera is impossible. Infected pens and refuse should therefore be burned, and the grounds should not be used for hog yards for several months.

The extensive use of swill from hotels as hog feed sometimes causes profuse diarrhea or death, and this trouble has often been mistaken for hog cholera. Such swill contains large quantities of washing soaps. These soaps when fed to hogs in doses of from ½ to 5 ounces per day produce diarrhea, staggering gait and a pink coloration of the skin.

Swine Plague is an infectious disease resembling hog cholera and frequently occurring in combination with the latter. In swine plague the chief seat of infection is in the lungs, and some form of pulmonary affection is nearly always the direct cause of death. Natural infection with swine plague takes place through the air passages, while in hog cholera infection occurs through the feed. A reddening of the skin indicates hog cholera rather than swine plague. It is often impossible, however, to distinguish between the 2 diseases except by a microscopic study. Outbreaks of swine plague should be treated like hog cholera until sure it is not hog cholera, then with swine plague sera.

Swine Erysipelas, a disease primarily of shotes but occurring at times in hogs of all ages, is rapidly becoming one of the most important diseases of swine, particularly in the Midwestern States, where the disease occurs in an acute and sometimes rapidly fatal form. The disease frequently assumes a chronic form involving the joints and occasionally is observed as the so-called "diamond-skin disease."

Cause. Swine erysipelas is an infectious disease caused by a specific microorganism, *Erysipelothrix rhusiopathiae.* This organism is eliminated from the bodies of infected hogs and from so-called "healthy carriers," by way of feces and urine. Hogs pick up the infection by eating feed, drinking water, or rooting in soil contaminated with this organism. The disease may occur at any season of the year but is generally encountered during the spring, late summer, or fall months.

Symptoms and Lesions. Swine erysipelas is a disease which, without the aid of trained men and laboratory facilities, often may be extremely hard to differentiate from hog cholera. In the acute stage of the disease there may be one or more sudden deaths. High temperature, loss of appetite, stiffness of gait, and arched back may be noted. Sick hogs withdraw from the herd and lie in their beds but upon being disturbed start off with considerable activity.

Prevention and Treatment. No medicine has yet been found to be of any value for the treatment of this disease, but anti-swine-erysipelas serum properly administered in the early stages of the disease has considerable curative value. Since even trained observers have difficulty in distinguishing swine erysipelas from other septicemic conditions in swine, the swine producer, instead of trying indiscriminate treatments should call a trained veterinarian to make positive diagnosis with the aid of laboratory examinations and to prescribe proper procedures in each case.

Trichina Spiralis is a thread-like worm from 1/20 to 1/8 of an inch in length. In its immature stage the worm is found encysted in the muscles of various carnivorous animals, especially in man, hogs and rats. The adult worm occurs in the intestines of hogs, where it deposits its eggs. After hatching the young worms penetrate into the striped muscles, where they remain until taken into the stomach of some animal which eats the infested flesh. An ounce of infested pork may contain 300,000 worms.

Symptoms of intestinal infestation in hogs are grinding of the teeth, thirst and fever. After the young worms begin to enter the muscles the pig's legs become stiff and the animal lies down. While the worms are in the intestines repeated doses of strong vermifuge may expel them. For preventing infestation by trichina, rats should not be allowed to live in the vicinity of pigpens, since these animals are frequently infested with trichina and are killed and eaten by the hogs.

Thumps is a popular term for palpitation of the heart, which may be due to an attack of bronchitis, the presence of worms in the intestines, or indigestion. It may be treated by jalap, turpentine or digitalis, according to the origin of the disease.

Measles of pork is a disease due to the presence of the pork bladder worm in the muscles. The worm is the immature stage of one of the common tapeworms of man. Man becomes infested by eating measly pork. The symptoms in hogs are indefinite and the disease cannot easily be diagnosed except by meat inspection. The measle worm is found in various muscles of infested hogs, especially those of the abdomen, diaphragm, tongue, heart and neck. Measly pork should not be eaten unless cooked or otherwise treated, so as to destroy the bladder worms.

For anthrax, actinomycosis and tuberculosis of swine *see Cattle.*

SHEEP

During the past 40 years the number of sheep on farms has varied up and down from 33 to 50 million and is now over 49 million. There are of course sheep in every State but 16 States have over a million each, headed by Texas with 10 million followed by Montana, Wyoming,

California, Utah, New Mexico, South Dakota, Ohio, Idaho and others. Over 40 per cent of our sheep are on western range lands.

Breeds. There are 12 or more breeds of sheep in the U.S. which are commonly grouped into fine-wools, medium-wools and long-wools. The fine-wool class includes the Rambouillet, the American Merino and the Delaine. The chief medium-wool breeds are Southdowns, Shropshires, Hampshires, Oxfords, Dorsets and Cheviots. Cotswold, Lincoln and Leicester breeds are the principal long-wools.

MERINOS. The native American Merino is a lineal descendant of the old merino flocks of Spain. These sheep were first brought to this country in 1801. Under the skillful direction of American breeders their carcass has been increased in weight 25 per cent, the weight of the fleece doubled and the quality of the mutton much improved. Full grown Merino rams weigh from 120 to 180 pounds, and the ewes about 40 pounds less. The skin of the Merino is characterized by heavy folds, the wool is fine and very dense and the fleece will average from 10 to 15 pounds in the ewes and considerably more with the rams.

The Merino is a hardy sheep and a good rustler. It thrives in bands of 1 or 2 thousand where the pure mutton breeds cannot be successfully herded in flocks of over 200.

With the decline in the price of wool in late years the Merino has been largely crossed with the mutton breeds for the purpose of producing an all around wool and mutton sheep. Starting with pure Merino ewes and a pure Shropshire buck and using thereafter a pure Shropshire buck on the grade ewes, the Wisconsin Station succeeded in producing at the second and third crossing grades that could scarcely be distinguished from pure Shropshires. Several forms of the Merino have been developed, such as the Delaine which is larger and less wrinkled than the other types.

MERINO RAMS

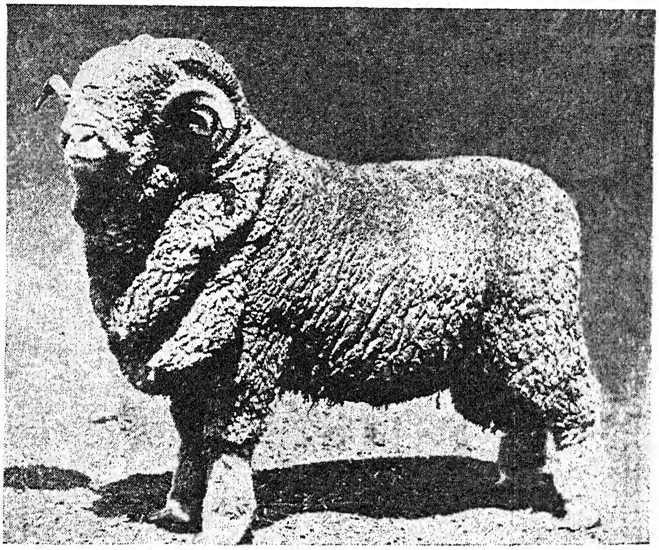
RAMBOUILLET. These are French Merinos built up from old Spanish Merino stock under government supervision and improved by careful selection and breeding since 1786. They are larger than the American Merino, full grown ewes weighing up to 200 pounds and rams to 300, live weight. These sheep have become very popular in this country during the past few years. They produce an especially fine fleece, which contains less gum and yolk than the American Merino fleece, and the mutton is of exceptionally fine quality. This combination of wool and mutton in the same sheep should make this breed remembered when a general purpose flock is to be established. Rambouillet rams are now largely used in alternation with Cotswold rams in flocks on Western ranges.

SOUTHDOWN. Practically all the improved mutton breeds of sheep are of English origin. The Southdown has been the basis of all the later so-called Down breeds, and is the type of a medium-wool mutton sheep. It is a smooth, round-bodied, symmetrical sheep with brown or gray feet and face. The fleece is rather dry, coarse and light. A good fat 2-year-old wether will weigh from 130 to 140 pounds. "The prominent characteristics of the Southdown are vigor, precocity, fecundity and well-marbled flesh at the most desirable points. They are especially desirable for crossing where mutton production is chiefly sought." The lamb crop may average 120 per cent of the ewes.

SHROPSHIRE. This is one of the most popular breeds of mutton sheep in this country. It is a well-proportioned, symmetrical sheep, a little heavier than the Southdown, the ewes weighing up to 175 pounds and the rams to 225 pounds. The face is grayish-black and the legs still darker. The wool is more compact and a little longer than Southdown, and the fleece will average 7 to 9 pounds in weight. It is a hardy sheep, does well on thin pastures, takes on flesh rapidly when fattened for market and is unusually free from common sheep diseases. It is one of the best general purpose sheep for farm flocks. At the Wisconsin Station Shropshire ewes proved more prolific than any other breed or cross except the fourth cross of Shropshire rams on Merino ewes.

HAMPSHIRE. The Hampshire is a hornless, black-faced, black-legged sheep, like the Southdown and Shropshire. It excels the Southdown in size, but otherwise is very similar to it. The breed is noted for rapid growth and is therefore favored for the production of early lambs.

OXFORD. The crossing of Cotswald rams on Hampshire ewes and the selection and mating of the progeny has resulted in what has been known since 1857 as Oxfordshire Downs or Oxford sheep. They resemble the Hampshire in many respects, but are larger, breed later and the face is not so dark. The mutton is of excellent quality and the wool of extra length.



RAMBOUILLET RAM

SUFFOLK. The Suffolks are nearly as large as the Hampshires and Oxfords, but are not quite so heavy.

DORSET. This breed is a little larger than the "Down" sheep, has white face and legs and both rams and ewes bear horns. It is the preferred breed for early lambs. The ewes may regularly be bred to lamb in the fall. Two lamb crops a year are possible but perhaps not advisable. Twinning occurs in about 30 per cent of cases and the ewes are heavy milkers. The Dorset is pre-eminently the breed for the production of hothouse lambs from Thanksgiving to Easter.

It is the custom to breed the ewes to a

Southdown or Hampshire ram in order to give the market lamb a black face, which is generally preferred by the butchers. No other breed is so prolific as this under skillful management. By crossing common grade ewes with a pure bred Dorset lamb for 2 or 3 generations and preserving the earlier dropped lambs for breeding uses the Wisconsin Station found that a flock can be built up which will drop their lambs in the fall and early winter instead of the spring. Such ewes can then be mated with the dark-faced mutton breeds to secure a superior quality of winter lambs for forcing.

Cheviots. This is a mountain breed of sheep, hardy and does well on scant pasture. It is grown very successfully in New York, Indiana, Iowa, Pennsylvania and North Carolina. Cheviot mutton is of superior quality. The fleece of the ewes will weigh from 6 to 8 pounds. The ewes weigh about 150 pounds and the rams 200 pounds. The breed is pure white except the nose which is black. The breed is of unusually strong constitution, excellent foragers and will secure a living where others might fail.

Lincoln. The Lincoln is one of the long-wool breeds, and, like all of these, is without horns. It is the heaviest of the mutton breeds. Its wool is 8 to 10 inches long and in high favor for making into the worsted class of goods. This breed has a white face and a conspicuous tuft on the forehead. In a test of breeds at the Iowa Station the Lincoln sheep produced the heaviest fleece, and the fleece which sold for the most money of any of 10 pure breeds under observation.

Cotswold. This is perhaps the most popular long-wool breed in America. It stands next to the Lincoln in size and in weight of fleece. It has a well-poised head with characteristic foretop, straight, broad back, well-rounded body, with a full brisket. The fleece is 8 to 10 inches long and weighs from 8 to 16 pounds. It is the oldest of the improved English breeds, possesses a hardy constitution and is well adapted for crossing on smaller Down and Merino breeds for increasing the weight of the lambs, lengthening the fleece and improving the quality of the mutton.

Leicester. This breed while popular in England is little grown and not highly esteemed by breeders here. It produces a good fleece and an excellent quality of mutton, but is not so hardy as some of the other breeds, besides requiring extra nutritious food and care for successful breeding.

There are several other breeds of sheep of less importance in the U.S. but worthy of brief mention:—

Romney Marsh is a hardy breed and survives under conditions of neglect. It is characterized by long carcass, flat sides, strong legs and long coarse wool, weighing 7 to 10 pounds per fleece.

The Corriedale, originated in New Zealand from Lincoln-Merino crosses, has become popular on the Western ranges as a dual purpose sheep, yielding both wool and mutton of excellent quality. The wool has something of the fineness and softness of the Merino.

Tunis or Broadtail is about equal to the Dorset in size, brown, reddish or white in color, very tolerant of heat. Next to Dorsets the Tunis are favored for hothouse lambs.

Karakul sheep are raised for their beautiful pelts in several localities, especially in the Western States, but have not yet attained great importance as an industry.

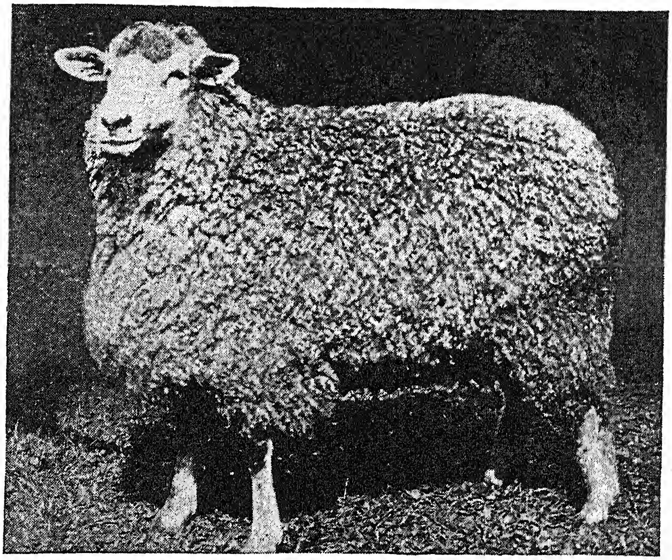
Winter Shelter for Sheep. Sheep on Eastern farms require winter shelter if they are to be profitable. If the flock is left out in driving rains and snow storms the fleece becomes wet through, the sheep chilled, and colds, snuffles and other disorders follow. Sheep will endure almost any degree of cold if it is dry cold. The shed or barn need be only one thickness of matched boards except when winter lambs are raised in the North, then quarters warm enough to prevent the chilling of new-born lambs are needed. Ventilation of sheep sheds is necessary, and for much of the winter the door of the shed may be a wide slat gate. Direct drafts on the sheep must always be avoided. The shed space should be about 10 square feet of floor space for each sheep weighing 100 pounds, or 15 square feet for each sheep weighing 150 pounds. A shed 20 by 40 feet will therefore be required for a flock of 80 sheep weighing 100 pounds each, or 50 sheep weighing 160 pounds each. From 18 to 24 inches rack space will be needed for each sheep. Feeding racks should have a flat, shallow bottom made of a single bottom board about 15 inches wide. Where grain is fed this prevents the sheep from bolting their rations.

Sheep Yard. The sheep yard should be dry and have a sunny exposure. It should be protected from bleak, cold winds and driving storms. The yard should be well littered with straw and the sheds comfortably bedded. Sheep require plenty of fresh air and sunshine and will

not do well if confined in barns warm enough for dairy cows nor in stone basements with damp walls.

Dividing the Flock. The flock should be divided, putting the breeding ewes in one flock and the lambs in another. If the wether lambs are to be fattened they should constitute a third flock.

Feed for Breeding Ewes. The ideal winter roughage for breeding ewes in the North is good clover hay, and in the West alfalfa. Well-put-up corn fodder stands



LINCOLN EWE

second in value. It proved superior in feeding value and cheaper at the Wisconsin Station when fed with oats and bran than either oat straw or blue grass hay and the same grain ration. The cost on corn fodder was but 1 cent per day per ewe. Next in value stand good prairie hay, cut oat straw, pea straw, barley straw, sorghum, etc.

In addition to these coarse fodders each ewe should be given ¼ to ½ pound of grain daily. With clover or alfalfa less grain will be required than when corn fodder or straw is fed. The grain ration should be made up preferably of whole oats, peas or bran or a mixture of these. The ewes require grains that will supply nourishment for the developing fetus rather than fattening grains like corn, which should be fed sparingly. A couple of tablespoonfuls of oil meal or linseed meal may also be profitably fed each ewe daily, and some succulent food like silage or roots. Corn silage proved as efficient and considerably cheaper for breeding ewes at the Wisconsin Station than clover silage or sugar beets. In one experiment the heaviest lambs were produced when the ewes were fed ½ pound of grain per head daily with 2½ pounds of corn silage and 2 pounds of mixed hay. As regards the milk supply of the ewes at lambing time the heaviest flow was secured when dried brewers' grains were fed. This also proved one of the cheapest rations fed.

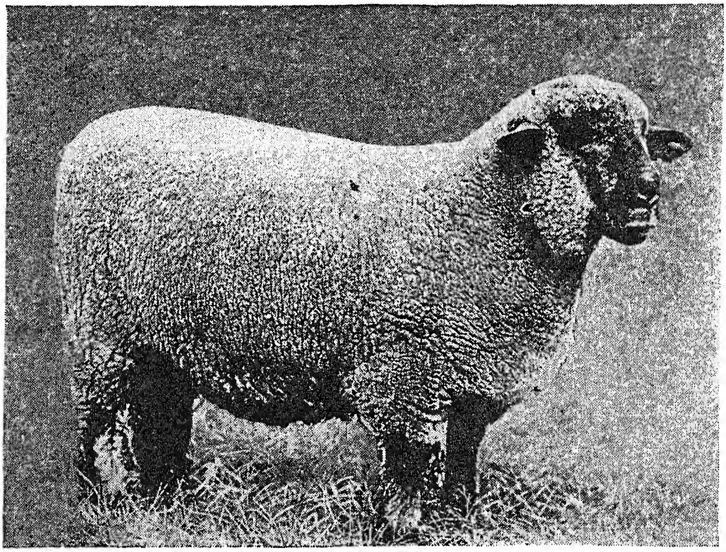
While it is the plan of many farmers to feed the breeding ewes on only the roughage of the farm, and generally without grain, it is not economy to do so, and weak-constitutioned lambs that feed badly and a degenerating flock result.

Cost of Wintering Breeding Ewes. The daily cost of wintering breeding ewes at the Iowa Station in a comfortable barn with food and water handy was as follows: Merinos, 1.03 cents; Cotswolds, 1.35 cents; Dorsets, 1.21 cents; Oxfords, 1.32 cents; Hampshires, 1.26 cents; Shropshires, 0.97 cent, and Southdowns, 0.6 cent per head. The ewes were given sufficient hay and grain to maintain them in good breeding condition. This test places the Southdowns first as the cheapest breed to winter, followed by the Shropshires, both costing less than 1 cent per head per day.

Flushing Ewes. This is an English practice to secure twin lambs. For 2 or

3 weeks before breeding time the ewes are given an extra supply of nutritious palatable food so that they may be gaining in flesh when breeding takes place. Well-fed ewes have more twin lambs than poorly fed ones, and tests at the Wisconsin Station show that ewes can raise twin lambs without losing any more flesh than when nursing a single lamb and that twin lambs nursing one mother gain as rapidly as when there is but one lamb nursing. Where the lambs are fed well, as is usually the case with the mutton breeds, twins are very desirable. Under average Western range conditions, however, where less attention can be given the flock, one lamb to each ewe has given most satisfactory results. At the Wisconsin Station ewes bred early in the mating season to a single ram dropped a larger percentage of lambs than when bred near the end of the season. Ewes 3 to 6 years old were most prolific.

In Oklahoma "flushing or increasing the feed available to ewes just prior to and during the breeding season was not found beneficial in an 8-year study. The improved nutrition did not result in more lambs or an earlier lamb crop, which are benefits commonly suggested for the practice. Grain feeding was used to increase the plane of nutrition in all cases except one lot which was fed green cowpeas. Fertility of the rams was found to be low during the hot summer weather when the ewes first came in heat, but improved when cooler fall weather arrived. This may account in part for the difficulty sometimes experienced in getting an early lamb crop in Oklahoma."



HAMPSHIRE RAM

Buck, Management. The buck is half the flock. The money put into a good first-class buck soon repays itself. Not a highly-fed show buck, but a strong, vigorous animal and a good getter of lambs. One buck is required for every 50 ewes. The buck should be turned in with the flock at night during the breeding season and removed in the morning. He should be kept in good condition on such grain rations as peas, oats, bran, etc., with good clover or alfalfa hay. One-year-old rams may be used but are not so prolific as rams 2 to 3 years old.

Sterility. English experience shows that in ordinary flocks about 4 per cent of the ewes are barren and 3 to 4 per cent more abort. Such ewes should be culled immediately from the flock and fattened for mutton.

Lambing. The period of pregnancy for sheep is about 21 weeks. In records secured at the Missouri Station the size of the lamb at birth appears to be influenced entirely by the size of the mother, large lambs being produced by heavy ewes and vice versa. The size or breed of the ram appeared to have no influence on this point. Male lambs are usually a little larger than ewe lambs. Heavy

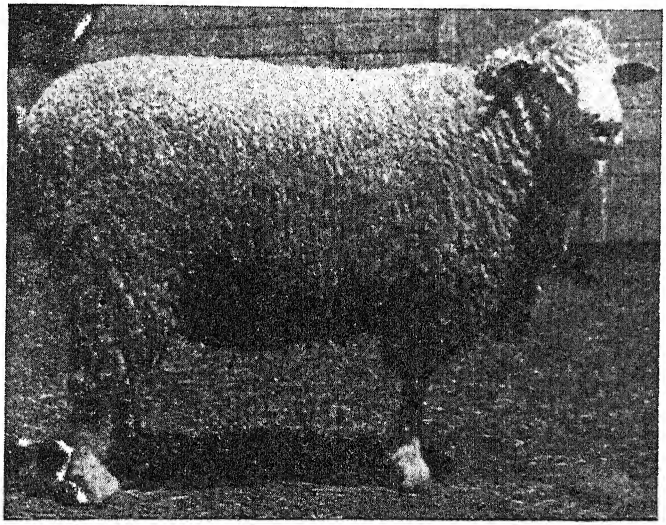
lambs made more rapid gains for the first 7 weeks than lighter lambs. The milk yield of ewes was found to vary from 1.83 to 3 pounds per day.

At lambing time the shepherd should be in constant attendance day and night. Especially is this desirable with the mutton breeds. If twins are born the ewe frequently gives attention to only the stronger one. The shepherd should see that the weaker one gets its full supply of food. If the young lamb is unable to suckle within a few minutes after birth it should have help, and it is often necessary to catch and hold the ewe for this purpose.

If the ewe refuses to own her lamb she must be shut up alone for a while with it in a small pen until she does own it. Sometimes the ewe dies in giving birth to the lamb, in which case it may be necessary to give the lamb to another ewe or bring it up on cow's milk fed in a bottle with a rubber nipple over the end. At first the cow's milk should be warmed and fed 12 to 15 times daily, and finally only 5 or 6 times.

After lambing the ewe should be fed sparingly on dry foods for 2 or 3 days. As the capacity of the lamb for milk increases the ration may be increased and more succulent foods added. With the coming of mild weather in the spring the lamb will be ready to go to pasture with its dam. On good pasture the ewes will require no grain.

Weaning Lambs. When lambs are about 4 months old they should be weaned, both for their own sake and for the sake of the ewe. "Let them be so far separated from their dams that neither can hear the bleating of the other. For a few days the ewes should be held on short pasture or kept in the yard on dry feed. Their udders should be examined and, if necessary, as is often the case with the best mothers, they should be drained of milk a few times lest inflammation arise. At weaning time the lambs should be put on the best pasture and given a liberal supply of grain in addition in order to mitigate the effects of weaning."



COLUMBIA EWE

Water and Salt. Sheep require to be supplied with fresh water. There may be times in wet weather or with heavy dews, or in the feeding of very succulent foods, when this is not necessary, but it is wise and profitable to provide from 1 to 6 quarts per head per day of fresh water. At the Montana Station at some winter fattening experiments lambs allowed constant access to fresh water gained over 2 pounds per head per month more and made gains a cent a pound cheaper than lambs fed the same foods but allowed water only once a day. In the Northwestern States sheep are watered once, twice or three times per day or, more rarely, every other day. Cold water proved as satisfactory as warm water for fattening lambs at the Colorado Station.

Salt is essential for sheep and should be

fed at regular intervals. Rock salt in lump form left where the sheep can get at it at will is a satisfactory method. On the Western ranges some sheep raisers never salt their sheep, but allow them to eat alkali. However, salt is better than alkali and salted sheep are less likely to become locoed. Alkali may, however, contain 80 per cent of salt, and is then quite safe for sheep. Finely ground limestone and steamed bone meal added to a silage ration gave a fine market finish.

PUREBRED HAMPSHIRE SHEEP

Feeding Lambs Grain Before and After Weaning. Whether or not it is advisable to feed lambs grain from birth or from weaning time until they are fattened for the market at 9 to 12 months of age is a question of importance to sheep growers. Some of the best and most conclusive experimental work has shown that in feeding lambs grain from birth, from weaning time and withholding it altogether until the winter fattening period, the important conclusion to be drawn is that it is financially profitable to feed lambs a grain ration continuously from birth, particularly if the lambs are to be sold at weaning time or in the fall; and the further conclusion is drawn at the same time that the grain ration after weaning when the lambs are on good pasture should not exceed ½ pound per head per day. The profit comes from the higher price that the mutton from the grain-fed lambs brings in the market and the fact that the grain-fed lambs are always in such condition that the feeder can take immediate advantage of any favorable rise in the market. For this purpose corn, oats, bran, peas or cottonseed meal are suitable.

When put on winter fattening rations the grain-fed lambs have made just as rapid gains as lambs that never had grain until the fattening period began and weighed as much 4 to 7 weeks from the end of the fattening period as the others did at the end. Methods of handling lambs to induce them to eat grain early in life are considered under *Hothouse Lambs* beyond.

On good blue grass pasture at the Iowa Station yearlings made practically as good gains, and considerably cheaper gains, as when grain was fed in addition. Mutton was made much cheaper in the summer on grass alone, or grain and grass, than by feeding grain and hay in the fall and winter. At the Minnesota Station wethers fed a small grain ration while on

good pasture made 60 per cent better gains for 112 days than wethers without grain.

Rape for Lambs. Dwarf Essex rape is yearly growing in favor and importance as a fall pasture crop for sheep, particularly in the Northern States and Canada, and also as a summer soiling crop for breeding ewes. Seeded in May the crop is ready for the first cutting 2 months later, and 2 more cuttings can be obtained by snowfall, or about 30 tons of green fodder per acre. The plant should be cut each time about 4 inches from the ground in order to secure the greatest abundance of new shoots.

As a fall pasture crop for fattening lambs the average results at the Wisconsin Station show a weekly gain on rape of 2½ pounds per head. With the rape about 1 pound of grain was fed daily to each sheep in addition. In one test at the station 2 like lots of 48 lambs each were fed the same amount of grain, but one lot was pastured on blue grass and the other on rape. In 4 weeks the rape-fed lot had gained 501 pounds and the lot pastured on blue grass 325 pounds. The lambs were then put up for the winter and fed like hay and grain rations. In 12 weeks the rape-pastured lambs gained 952 pounds and the lot pastured on blue grass 858 pounds, thus giving evidence of the value of rape in preparing lambs for winter feeding.

At the Michigan Station 125 grade Shropshire lambs were fall pastured for 7½ weeks on 15 acres of rape and made an average weekly gain of 3 pounds per head. The rape-fed lambs at that station have invariably been in better condition for fattening in November than grass-fed lambs, and in comparison have made practically as good gains in winter grain feeding. As a rule, the Station states, lambs may be pastured on rape from September 15 to November 15 at the rate of 15 to 20 lambs per acre and gain 20 pounds each. Lambs should never be put on rape without first pasturing them a few hours on grass or giving them a feed of hay and grain. Otherwise they are very liable to bloat and some of them be lost. The flock should be accustomed to the rape gradually, and in the beginning should not be left on more than 2 hours at a time. After 5 or 6 days they may be left on all the time, but must be carefully watched, and if any signs of bloat appear should be promptly driven from the field. It is much safer if some other pasture is fed in connection with rape. Before turning the lambs on the rape they should be docked and trimmed. In Illinois lambs thrived well on a mixed pasture of oats, red, sweet and alsike clovers, timothy and rape.

Pasturing Sheep on Alfalfa. Sheep pastured on alfalfa are very liable to bloat. Some sheep are practically certain to be lost, but the danger can be largely overcome and the loss reduced to at least 5 per cent by the careful observation of certain precautions. These are stated by the Colorado Station as follows: The sheep should be kept in small bunches. The field should large enough to supply them with an abundance of food with but little effort. They should be left in the field night and day and not removed when the field is irrigated. Keep water and salt within their reach all the time and provide shelter from sun. They should be filled up with some other food and not thirsty when turned on the alfalfa. Old sheep are more liable to bloat than lambs.

Lambs vs. Yearlings for Feeding; Mexican Lambs. The Iowa, Minnesota and some other stations have made special tests to determine the relative merits for fattening of lambs (6 to 9 months old), yearlings and 2- and 3-year-old wethers. As a rule the lambs have gotten about a half more out of the food given them than the older sheep. The lambs gain faster, make a pound of mutton cheaper and sell for a higher price in the market. Yearlings and older sheep should be bought for considerably less per 100 pounds than lambs if they are to be fed at a proportionate profit. The Colorado Station has shown that large lambs make better and cheaper gains than small ones of the same age. In tests at the station Mexican lambs have been fed at a greater net profit than Mexican yearlings, grade Merino lambs or grade Merino yearlings, whether figured per dollar invested or per ton of hay fed. Lambs also shrunk less in shipping to Chicago and in dressed weight than yearlings. At the Minnesota Station Merino grade lambs made poorer and more costly gains than Shropshire, Oxford or Cotswold grade lambs.

Influence of Breeding on Feeding Qualities of Lambs. Shropshire grade lambs grown under indifferent management and in flocks where little attention had been given to the selection of good rams, and the culling of the flock, were fed at the Wisconsin Station in comparison with average wether lambs from the carefully managed station flock. Both lots were given all they could eat of corn

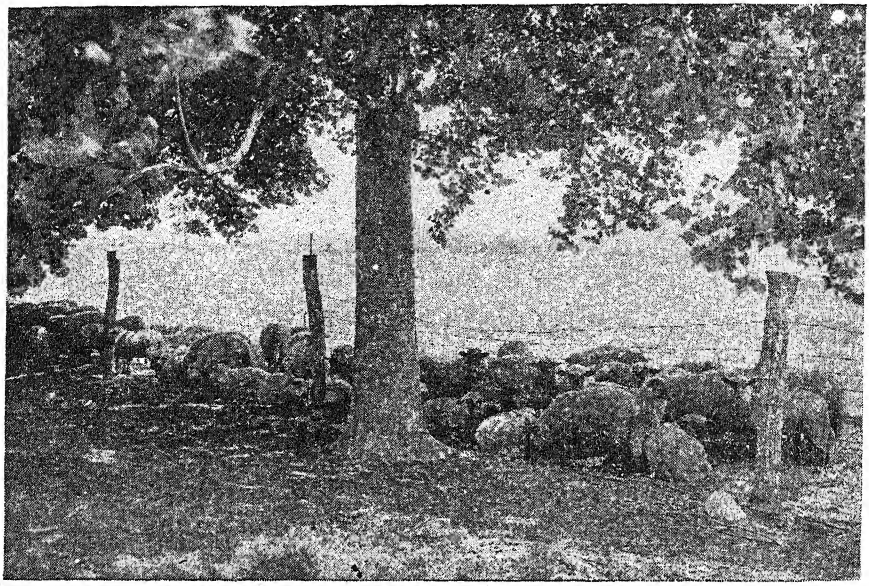
fodder and a mixture of equal parts corn and peas. The average weekly gains were 2.27 pounds per head for the scrub lambs and 3.6 pounds per head for the well-bred lambs. The cost of 100 pounds of gain with the scrub lambs was $4.58 and the profit per head 65 cents. With the well-bred lambs the cost was $4.08 per 100 pounds of gain and a profit of $1.13 per head.

Self Feed for Fattening Sheep. A "self feed" is an arrangement by which sheep may supply themselves with grain at any time. It makes a convenient way of feeding sheep since all that is required is to see that the "feed" is supplied with grain at all times. In Michigan there was virtually no difference in the rate of gain between hand-fed lambs and self-fed lambs on the same ration.

Shearing Sheep When Fattening. It is often claimed that if sheep are shorn while they are being fattened they make more and better gains. At the Wisconsin Station when the lambs were shorn early in the season—October—they made more rapid gains for the next 6 or 7 weeks or until the wool reached a length of 1 or 2 inches, and at a slightly cheaper rate than unshorn lambs. But when the fattening period extended over a period of 3 or 4 months there appeared to be no practical advantage whatever in fall shearing, the unshorn lambs making as good gains in the long run as the shorn lambs and the increased length of the wool fiber counterbalancing in value the slightly greater weight of wool from the lambs sheared both in the fall and in the spring.

At the South Dakota Station lambs that had been fed 16 weeks and were ripe for market were shorn and fed heavily for 4 weeks longer. Practically no return whatever was obtained for the grain fed and consequently all the food, labor and risk involved in keeping the sheep this extra period was a total loss. Feeders are cautioned against attempting to get profitable gains out of sheep after they are finished, by simply taking off their fleece. At the Michigan Station where lambs were fed for 13 weeks, then sheared and kept in a warm barn for 3 weeks longer, they made slightly increased gains, but in another test when they were sheared in December and fed until the latter part of February, they suffered considerably from cold, required a half more feed to make a pound of gain and made less total gain than unshorn lambs.

These experiments indicate that early shearing in October may be a beneficial practice to prepare lambs that are 6 months old for the early winter market, but there appears to be no advantage in shearing them at any other period.



FARM FLOCK AT PASTURE

Fattening Sheep. In general it takes about 400 pounds of hay and 500 pounds of corn to produce 100 pounds of gain with sheep. It takes from 12 to 16 weeks' good feeding to fit lambs for the market. If the feeding has been well done the lambs, at the end of this period, will be "ripe" for market. That is they will be so fat and well filled out that further gain cannot be made at a profit. In a test at the Minnesota Station it cost 4.17 cents to make 1 pound of gain a the beginning of the feeding test and 23.17 cents at the end. At the North Dakota Station 19 sheep were fed a heavy grain ration for 4 weeks after they were "ripe." They gained but 5 pounds during the whole period, thus showing that any feeding done after the lambs are "ripe" is done at a loss.

With proper feeds and under good conditions, lambs will gain about ¼ of a pound a day, or from 25 to 30 pounds in 14 to 16 weeks. It requires 8 or 9 pounds of dry matter to produce 1 pound of gain with lambs and from 30 to 40 per cent more with older sheep.

Sheep make cheaper gains and can generally be fed at a greater profit than cattle. At the Iowa Station lambs ate 48 per cent more per 1000 pounds live weight than growing cattle and gained 75 per cent more. Foreign experiments confirm these results. For comparison of sheep, cattle and pigs as regards the quantity of different feeds required to produce a pound of gain *see* under *Feeding Farm Animals*.

Rations for lambs must be palatable and suited to growth as well as fattening or else the lambs will not continue to eat vigorously, and without a vigorous appetite they cannot be fed with profit. The chemical composition of the ration is not of so much importance as its palatability. The best eaters in the flock make the largest and cheapest gains.

Alfalfa, Alsike, Clover, Cowpeas for Sheep. The best forage for fattening lambs in the East is red clover hay and in the West alfalfa. Feeding tests at the Montana Station resulted in placing alsike clover ahead of either of these hays for fattening lambs, but the range of growth and yield of this crop is not so great as either alfalfa or red clover. Lambs fattened on clover alone without any grain whatever at the Montana Station gained 8.1 pounds per head per month. At the Ontario Agricultural College clover and alfalfa possessed about equal feeding values for sheep. At the Nebraska Station lambs fed alfalfa hay and grain made 52 per cent better gains than like lambs fed the same grains and prairie hay. When sorghum was substituted for prairie hay the lot fed alfalfa made 72 per cent better gains. In these tests the lambs on both prairie hay and sorghum were fed at a profit. At the Wyoming Station, where alfalfa was compared with native hay as a roughage for fattening lambs fed like grain rations, the lambs on alfalfa made 25 per cent better gains than the lambs on native hay. Stated in another way, an acre of native hay produced 476 pounds of mutton, while an acre of alfalfa produced 1756 pounds. Cowpeas are the great leguminous crop of the South and in that section of the country take the place of alfalfa and red clover. The experiment stations have reported but one feeding experiment with sheep with this crop, in which at the West Virginia Station it was shown to be much superior to timothy.

Corn Fodder, Bean Straw, Oat Straw, Timothy, etc. for Sheep. Next in value to the leguminous forage crops mentioned above stands cut corn fodder. It makes the best fodder and furnishes the most grain if cut when the grain is beginning to dent and the lower leaves are beginning to turn color. In experiments at the Utah Station well-cured fodder corn cut up before feeding, gave equal or better gains with sheep than corn silage, and the flesh produced on the fodder corn was not so watery. For breeding ewes cut corn fodder proved superior to either corn silage, oat straw or blue grass hay at the Wisconsin Station. In another test, however, corn silage proved a cheap and very satisfactory feed for breeding ewes.

Timothy hay and good oat straw had about the same feeding value in feeding experiments with sheep at the North Dakota Station. The gains on timothy and grain were at the rate of 2¼ pounds per head per week, and on oat straw and the same grain mixture 2⅛ pounds per week. At the Michigan Station a number of forage plants were successfully substituted for clover hay in fattening experiments. Cheap and substantial gains were made on all of the following roughages: millet hay, oat straw, bean straw, corn stalks and alfalfa, mentioned in the increasing order of their value as substitutes. Care had to be observed in feeding the millet hay as it induced scours.

Silage and Roots for Sheep. These crops add succulence and palatability to

the ration and are greatly relished by sheep. In England sheep are largely fattened on roots and grain, and roots are grown in enormous quantities for this purpose. In this country corn silage is used to a greater extent than roots. Clover and other silage (*see Silage*) is also fed to some extent.

Tests at the Massachusetts and New York Cornell Stations indicate that with sheep 4 pounds of corn silage are about equivalent in feeding value to 1 pound of the Ontario Station lambs fed roots with hay and grain gained 2.12 pounds each per week as compared with a gain of 1.8 pounds per week when silage was fed with hay and grain.

In a test of succulent vs. dry rations for fattening lambs at the Wisconsin Station, a lot fed on hay and grain alone gained 2.6 pounds per head per week. When silage was added to the ration the weekly gains were 2.3 pounds per head and when roots were added 2.4 pounds. The flesh

SHEEP GRAZING ON RAPE

hay—mostly clover. In tests at the New York Cornell Station with hothouse lambs, a lot receiving all the roots (long red mangel-wurzels) it would eat in addition to other feeds, gained on an average 3.44 pounds per head per week, while another similar lot given all the corn silage of good quality it would eat gained 3.85 pounds per head per week.

At the Michigan Station in a test of corn silage vs. sugar beets for fattening lambs fed alike in other respects, the gains per lamb on silage averaged 2½ pounds per week and on sugar beets 3 pounds per week. In another test good corn silage was fed against cut rutabagas for fattening lambs. The gain was the same with both lots, 1.7 pounds per week, but the root-fed lot made a profit of only 22 cents per head, while on the corn silage the gain was 63 cents per head. At of the lambs analyzed 49.39 per cent water for the lot fed roots, 43.84 per cent for the lot fed silage, and 43.11 per cent for the lot on hay and grain alone, thus showing that succulent rations tend to the production of a watery flesh. At the New York Cornell Station in a feeding test lasting 4½ months, lambs on hay and grain gained 24.8 pounds per head. When corn silage was added to the ration the gains were 26.5 pounds per head.

So far as these tests go they would seem to indicate that silage has no special virtue over cut dry feeds for sheep, and that it is about equal in feeding value to roots, but very much cheaper than roots and most dry fodders.

A test was made at the Minnesota Station of the relative feeding values of mangels, sugar beets and potatoes for fattening range lambs. The lambs were fed

like grain rations of corn, barley and oil meal and hay and all the roots they could eat in addition. Each lot of lambs ate about 3½ pounds of roots per day. At the end of 110 days the lot receiving potatoes had gained 32.9 pounds; on mangels 30.6 pounds, and on sugar beets, 34.6 pounds. These results are slightly in favor of sugar beets and potatoes. The relative high cost of potatoes, however, make their use much less profitable than either of the other roots.

At the Utah Station a lot of lambs fed roots (beets and turnips) gained 17 pounds per head in 3 months, while another lot fed the same ration without roots gained but 10⅓ pounds. The flesh of the root-fed lambs analyzed 49.48 per cent water, while the flesh of the other lot contained but 40.77 per cent of water —results which are concordant with those reported from Wisconsin above.

Experiments in Washington indicated that the main value of succulent feeds appeared to be in their hay replacement. Neither the ewes nor the lambs receiving succulent feeds showed noticeable response over those receiving no succulents. The relative value of the various succulent feeds based upon their hay replacement value was as follows:

Potatoes were worth from 15 to 25 per cent as much as chopped alfalfa hay when fed at rates from 1.7 to 3 pounds per head daily.

Potatoes were worth from 15 to 25 per cent as much as chopped alfalfa hay when fed at the rate of 1.6 pounds per head daily.

Rutabagas did not reduce hay consumption.

Wet beet pulp was worth from 6.5 to 7.5 per cent as much as chopped alfalfa hay when fed at the rate of 4.7 pounds per head daily.

At the Maine Station it was found that the dry matter in roots (rutabagas) has no special and peculiar value beyond the small quantity which it may be wise to feed for the purpose of giving variety to the ration. Roots added to a grain ration gave 70 per cent better gains at the Minnesota Station than the same ration without roots, and the net profit was considerably larger.

These experiments would seem to indicate a high feeding value for roots, on a par at least with corn silage for fattening purposes. When it is considered that sugar beets fed in quantities greater than 4 pounds per head per day induce scouring and that the cost of production is considerably greater than most other roots and than corn silage, it would seem that in regions where corn can be grown it is sound business policy to put up corn silage for sheep rather than grow roots, since it can be grown much cheaper and preserved better than roots or almost any other silage, is palatable and conducive to good gains.

Grains for Sheep. Many experiments have been carried out by the experiment stations with the different grains for fattening sheep. Some of the more important of these will be noted below.

Barley. There are 2 kinds of barley, common and bald. The bald barley contains an unusually large amount of proteins compared with common barley. At the Colorado Station, where these 2 barleys were fed to fattening lambs in comparison with other grains, slightly more gain was made on bald barley than on corn. The lambs, however, were unable to eat more than a pound per head per day without getting off feed. Common barley produced about the same gains as wheat but did not quite equal corn. Whole barley gave better results than ground barley.

These experiments rank barley as among the best farm grains for lambs. Owing to its comparative richness in nitrogenous material it is adapted to growth as well as fattening and therefore is one of the best grains for feeding lambs in the early stages of fattening. (*See* also *Barley.*)

Corn. Corn is King of the grains in the final stages of fattening sheep. It should be fed whole except to old sheep and to lambs before weaning. For fattening corn is the standard by which other grains are measured. It is the cheapest grain and the one produced most abundantly in this country. It is not so safe to feed as a single grain ration and in large quantities as some of the other grains, since it is liable to occasion various digestive disorders in the flock and they easily get off feed on it.

In a series of experiments extending over a number of years at the Wisconsin Station, greater but more costly gains were made on corn and peas mixed. In a comparison of corn and wheat at the Colorado Station the wheat gave a better growth in the early stages of feeding than corn, but later better gains were made on corn. The station believes it best to feed wheat the first third of the winter, then half wheat and half corn for the next third, finishing off on clear corn. In fat-

tening older sheep corn is considered by far the best grain to feed. (*See* also *Corn.*) At the Iowa Station corn at 33 cents a bushel was a more economical grain to feed the sheep on grass than oats at 23 cents or barley at 40. In Oklahoma cottonseed meal added to rations of corn and alfalfa hay produced a desirable market finish in lambs and did not interfere with appetite or rate of gain.

EMMER is considered below under *Spelt.*

KAFIR CORN. Not many data have been accumulated on the feeding value of Kafir corn for sheep. At the Oklahoma Station a wether lamb fed 2 pounds of Kafir meal a day with crab grass hay gained 13 pounds in 4 weeks. On the same ration a Shropshire ram gained 17 pounds in the same time. Again 3 wether lambs and 3 rather inferior yearlings were fed Kafir grain for 52 days and made an average gain of 2.87 pounds per head per week, requiring 5.82 pounds of grain for each pound of gain. These tests show a very high feeding value for Kafir corn grain. (*See* also *Kafir Corn.*)

OATS. On whole oats and timothy hay at the North Dakota Station lambs gained 2½ pounds per head per week for 8 weeks. At the Minnesota Station, where oats were fed with corn, bran and hay to lambs, 36 per cent better gains were made than when oats were omitted from the ration. The total amount of grain consumed was the same in each case. Oats are usually too expensive to constitute the whole grain ration for fattening sheep. Added to corn they give variety and palatability to the ration. Sheep make good gains on oats and an excellent quality of mutton, and when they are cheap enough they may be profitably fed. Ordinarily they should constitute only part of the grain ration for fattening sheep. For breeding ewes or in the production of wool they make one of the best grain rations.

PEANUTS. In Georgia peanut meal has proved an efficient supplement to other feeds for fattening sheep, and for ewes with lambs, because of its milk producing qualities. From ⅕ to ½ pound per head was used with good results in rations of corn and legume hays. Salt and lime should be added to the feed.

PEAS. Canada field peas make an excellent growing ration for lambs and when fed in equal parts with corn have produced 20 per cent better gains with older lambs at the Wisconsin Station, than corn alone or corn and oats. Sheep relish them and the quality of the mutton made on them is of the very finest. On peas and oats at the Ontario Agricultural College, lambs gained 2.10 pounds per head per week and on corn and oats 2.29 pounds. In another test a lot of lambs fed corn alone gained 2.52 pounds per week; peas 2.91 pounds per week, and equal parts corn and peas 2.6 pounds. The grain consumed per pound of gain was 3.8, 3.3, and 3.68 pounds respectively.

SCREENINGS. When wheat is cleaned at the elevators enormous quantities of screenings, consisting of broken wheat kernels and shrunken grains, weed seed, chaff, etc. accumulate. At the Minnesota Station the feeding value of screenings was placed at about ¾ the value of corn or barley. At the North Dakota Station lambs fattened on wheat screenings gained 2 pounds per head per week at a cost of 5.22 cents per pound of gain. At the Utah Station the gains on screenings for 3½ months varied from 1.44 to 1.68 pounds per head per week.

SPELT OR EMMER. This grain was found by the South Dakota Station to have a feeding value for fattening lambs ⅔ that of barley. Lambs fed all the hay and spelt they would eat gained 1.67 pounds per head per week for 3⅓ months. In another test with sheep on grass it required twice as much spelt as corn to produce a pound of gain, and a third more spelt than barley, oats or wheat to produce a pound of gain.

At the Iowa Station spelt pound for pound proved practically as valuable as corn for fattening wethers. At the Colorado Station spelt proved cheaper pound for pound than corn and resulted in larger gains for fattening lambs.

WHEAT. Tests at Colorado, Michigan and at other experiment stations show that wheat is about 10 per cent less valuable than corn for fattening lambs. It conduces to growth and is therefore well adapted to feeding in the early stages of fattening. At 50 cents a bushel it is more profitable to feed wheat than to sell it. Frosted wheat, or unmarketable shrunken wheat seems from tests in Utah to be fully as valuable for fattening purposes as good marketable wheat. Macaroni wheat, either ground or whole, proved as good a feed for lambs as common bread wheat and nearly as good as corn in experiments at the South Dakota Station.

The amount in pounds of different grains required for 100 pounds of gain in sheep as determined by a large number

of experiments, are shown in the following table:

Barley	Corn	Kafir corn	Oats	Peas	Wheat	Mixed grains
453	502	582	518	422	582	454

Hothouse Lambs. This is probably the most profitable phase of the sheep industry when properly managed. It consists in the production of fat lambs weighing 35 to 60 pounds live weight, and the marketing of these during the period between Christmas and the following March or April. The chief markets are the larger cities like Philadelphia, New York, Chicago, etc., but there is a growing yearly demand in all the smaller cities for winter lambs. A few lambs can be sold at Christmas time, but the market is rather limited at this period, owing to the large amount of poultry then on the market. The best market comes in January and February and up to about March 15. From March on the price for winter lambs, while a little higher than for lambs born earlier in the season, is not so good as in January and February.

Best Breeds for Winter Lambs. The chief difficulty in the production of early winter lambs is in getting the ewes to breed, so that they will drop their lambs in October, November and December. The two pure breeds apparently best suited for this purpose are the Dorset and the Tunis. The Dorset is much the more popular of the two.

Various other breeds of sheep are also used to produce winter lambs, but are not so satisfactory as the Dorset, because there is no uniformity in the early breeding. A few may breed in May and along during the summer, but most of them will not begin breeding until September and October, which is too late for the best prices of winter lambs. The Dorsets are big milk yielders, leading all other breeds in this respect. The lambs are sent to market while suckling the ewe and a large and continuous supply of milk is a vital factor in their rapid growth. On this account Dorset lambs grow faster and arrive at a marketable age sooner than most other pure breeds.

Dorset and Shropshire Ewes. In experiments reported by the New York Cornell Station, pure bred Shropshires were compared with pure bred Dorsets to determine their relative value for winter lambs. The Shropshire lambs averaged 9.7 pounds at birth, and 42.75 pounds a head 9 weeks later, thus making an average weekly gain of 3.5 pounds per head. The Dorset lambs averaged 10.6 pounds at birth and weighed 53.5 pounds a head when 9 weeks old, having made an average weekly gain of 4.8 pounds a head. The following year, when the experiment was repeated, the Shropshire lambs gained on an average 2.87 pounds apiece for 12 weeks, and the Dorset 4.47 pounds. In both experiments the lambs of both breeds were given all they would eat. The Dorset ewes ate more food than the Shropshire ewes, stood forced feeding better and were less affected by changes in the weather than the Shropshires.

When grade Shropshires and grade Dorsets were compared, the lambs from the grade Shropshire ewes made an average weekly gain of 2.66 pounds a week and from the grade Dorset ewes 3.64 pounds. Here again the advantage of Dorset blood in the ewes for producing rapid growing lambs is shown.

Shropshire vs. Merino Ewes. The Colorado Station investigated the relative merits of Shropshires crossed on Merinos as compared with Dorsets crossed on Merinos for producing early lambs. In these experiments the Dorset-Merino produced about 20 per cent more lambs than the Shropshire-Merinos, and on this account were about 16 per cent more profitable. The gains in feeding were about the same for both crosses, as were also the prices received for them.

Feeding Hothouse Lambs. The lambs will begin to eat when about 3 weeks old. It is very desirable that they be given fresh pasture, such as clover, alfalfa, rape, peas and oats or some similar forage which they relish. They learn to eat grain just as soon as they learn to eat forage. The best grains are ground corn mixed with ground peas, oats or barley. When about 4 weeks old they will eat as much as a pound of grain a head daily. They may be given all they will eat up clean without fear, as at that age they practically never overeat. A little sugar sprinkled on the grain may aid in teaching them to eat it. The grain should be varied every 2 or 3 days to keep up their appetites and interest.

It has been noticed that lambs will eat a particular kind of grain with considerable relish for a day or two and then seem to tire of it and consequently consume less. Before this stage is reached a change in the grain ration should be made. The observant feeder will soon note the kind of grain relished best by the lambs. Whole oats and whole wheat are readily eaten. A lamb creep should be provided so that the lambs can be fed away from the ewes. A self-feed arrangement is not desirable with the lambs since they muss over much of the feed, which thus becomes unsavory and often ferments. Cleanliness in feeding, while desirable for all sheep, is especially so for winter lambs.

Lambs born in the late fall and early winter, in addition to the ewe's milk and grain, should be liberally fed with the best quality of clover and alfalfa hay and given silage or sliced roots in addition. In a test at the Cornell Experiment Station, of the relative value of these two succulent foods for winter lambs, a lot fed all the roots (mangel-wurzels) it would eat, in addition to other feeds, gained on an average 3.44 pounds a head weekly, while another similar lot fed corn silage of good quality gained 3.85 pounds a head weekly. These results are in favor of the silage. Many feeders, however, prefer roots. The latter, however, are more expensive.

Grain Alone for Sheep. At the Utah Station sheep were fattened on grain and beets without any other coarse fodder whatever. At first the sheep decreased in weight, but gradually picked up and for 4 months gained .17 pound per head per day. When killed at the end of the period the sheep were very fat and the mutton tender and well flavored.

Milk for Lambs. Lambs at the Wisconsin Station made nearly as good gains when fed skimmilk as young pigs do on this feed.

Pasture is an important feature of sheep raising. But sheep are more troubled by parasites than other farm animals. For example the gid worm, a bladder worm in the brain of sheep, is one stage of a tapeworm in dogs which lays eggs to be passed out in the feces of dogs in sheep pastures where they are eaten by sheep while grazing and later produce the symptoms of gid. The thin-necked bladder worm in the liver of sheep is also a form of a tapeworm in dogs and is similarly transmitted from dogs to sheep.

CORRIEDALES IN WYOMING

Perhaps the most destructive parasite of sheep is the stomach worm. But this pest has forced upon the sheep raiser a rational system of pasture rotation. The eggs of the stomach worms pass out with the manure and the young worms crawl upon the pasture grasses and thus reinfest the sheep. As M. C. Hall states it "permanent pastures perpetuate parasites."

The obvious remedy for that trouble is found in the use of temporary pastures or frequent changes from one pasture to another. Liming and the application of phosphatic fertilizers every alternate year

greatly increases the carrying capacity of fields of low fertility. "It is chiefly necessary to have a crop ready when the preceding one is finished. In the Middle Atlantic States fall sown wheat, rye and barley, followed by spring sown oats and peas, soybeans and fall seedings of the cereals, will usually furnish continuous grazing from April to November." Such treatment of infertile land should furnish grazing for 3 sheep for each 2 acres for a 200-day period. If really fertile meadow land were used in the same manner from 50 to 100 per cent more pasturage would be obtained. Where movable fences are used on good pasture land it is well to allow one acre to 25 sheep for a period of 10 to 14 days. By going to new ground every 10 days the risk that the sheep will pick up stomach worms on previously grazed ground is greatly reduced.

Range Method of Sheep Raising. In the Rocky Mountain and Pacific Coast States, where sheep raising is conducted on a large scale, the methods of managing sheep are far different from those commonly used in the Eastern States. The sheep are divided into bands or herds of from 2000 to 3000, under the constant care of a herder, who has 1 or 2 dogs to assist him in controlling the sheep. The sheep obtain sufficient forage the greater part of the time by grazing on the open range, and in many localities they are successfully managed on the range for the whole year without the necessity of feeding hay at any time. It is especially true in the Southwest, and even in parts of Wyoming and Montana, where sufficient forage for sheep is found on the mountains during the whole year. The grazing ground at the disposition of each sheep owner is divided into summer and winter range. During the winter and spring until after shearing and lambing time, the sheep are kept conveniently near to the ranch house. In summer they are driven into the mountains, where they graze until forced out by the mountain snowfall of the late autumn. Under Federal inspection permits are granted for such movements.

During the lambing season a lambing wagon is kept in attendance on each band of ewes, and the lambs and ewes are picked up and taken to lambing sheds as soon as the lambs are born. Here the ewes and young lambs are kept in small herds of from 25 to 50 until the lambs are a few days old and have been "owned" by their mothers. When the lambs are from 10 days to 2 weeks old they are docked and marked. The various operations connected with the management of sheep take place at different times in different States. The professional shearers are busy the year round, operating in South America and Australia during our winter season and beginning shearing in this country in the extreme Southwest early in the spring. From this point they gradually work northward, and the shearing season ends in Montana about July 25. Expert men easily shear 100 sheep per day, either with hand shears or with the shearing machines. Exceptionally good men shear 200 or more per day. The machine shearing plants are of various sizes, accommodating from 10 to 40 men, and are gradually displacing hand shearing in many parts of the country. The chief advantages of machine shearing are a smoother cut of the fleece and a somewhat larger clip. It is estimated that from ½ to 1 pound more for each fleece is obtained by shearing by a machine.

The surplus of old sheep and lambs is usually sold each year for mutton. These are either shipped East immediately without any attempt at fattening, or they may be fattened before shipping. The usual feeding materials for this purpose are alfalfa and roots.

The sheepmen of the Northwestern States at present prefer a crossbred sheep bearing wool of medium fineness. Usually an attempt is made to secure a general purpose sheep. Coarse wool bucks, either Cotswold or Lincoln, are used for about 2 seasons, and then in order to prevent the wool becoming too coarse a change is made to fine wool bucks of some Merino breed, of which the Rambouillet is at present in great esteem. Each fleece is tied up with twine and the fleeces are then put in wool sacks, being packed as firmly as may be done by the tramping of a man employed for this purpose. The weight of the full sacks averages about 400 pounds.

Diseases. For an account of the medicines and of the doses mentioned under the diseases below *see Veterinary Medicines.*

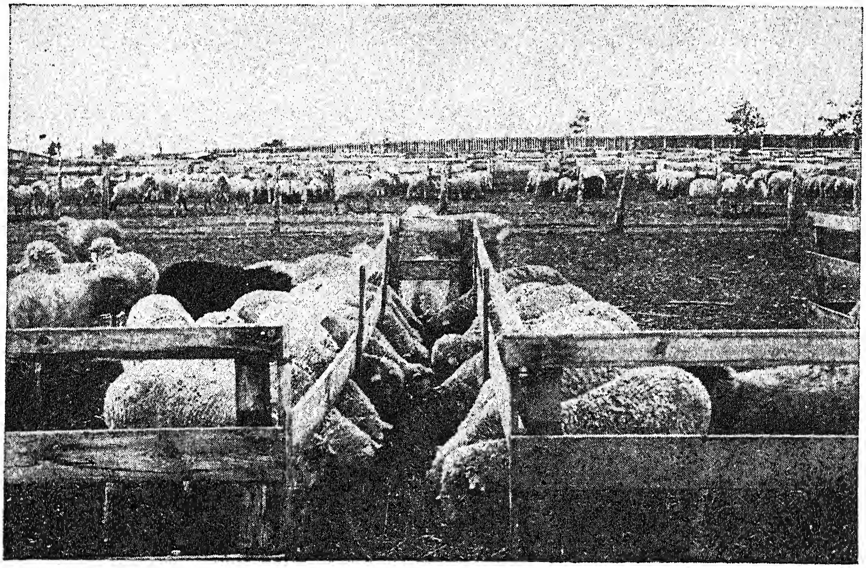
SCAB is a contagious disease due to the scab mite (*Psoroptes communis* var. *ovis*). The mite punctures the skin of the sheep to obtain its food and thus produces an itching and irritation which finally results in the formation of pustules. From these pustules a fluid exudes which in drying forms scabs, under which the mites live. As the mites multiply they move out from the center of infestation and establish themselves upon healthy skin. The ir-

ritation produced by the presence of the scab mite renders the sheep restless. They bite and pull the wool from affected areas, rub against fences and brush against other sheep. The tendency to rub against various objects is one of the first symptoms of sheep scab. Soon a loose lock of wool is seen projecting from some place upon the back or side of the sheep. The scabby area increases in size and a bare spot of greater or less extent is exposed. The mites gradually spread over the body until all the skin of the upper part is scabby. Affected animals usually die unless treated.

Experiments have shown that scab mites may live from fall to spring or from spring to fall in the soil of infested localities without obtaining any nourishment from sheep. Eggs kept at a temperature near that of the body hatch in about 4 to 8 days.

The most satisfactory method of curing scab consists in dipping the sheep in some liquid which will kill the mites.

Experiments have been made with a large number of dips for this purpose including coal tar creosote, cresol and nicotine dips, all of which are satisfactory. A second dip should be given about 10 days after the first in order to destroy mites that may have hatched from eggs which were present at the first dipping. In some badly infested localities it is necessary to dip the sheep once or twice annually without waiting for the appearance of scab.

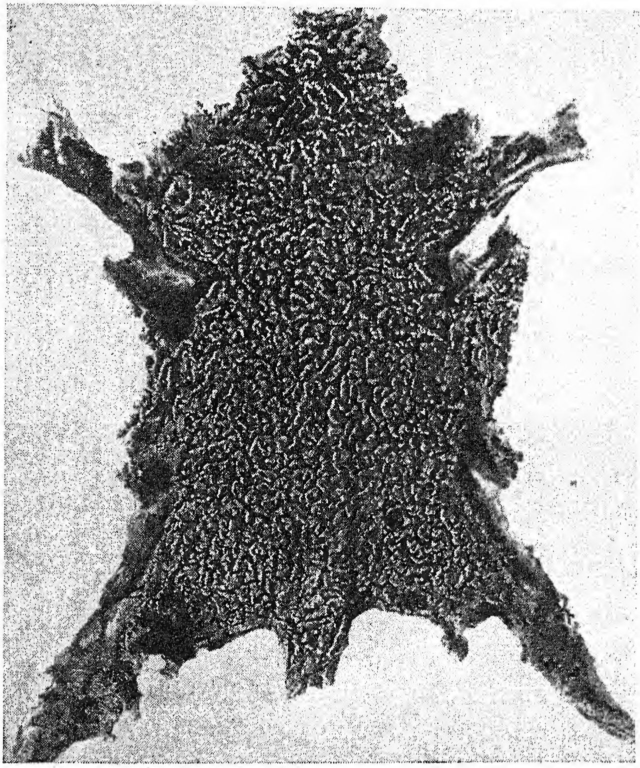


FEED YARDS IN UTAH

Gid or Staggers is a disease caused by the immature stage of one of the tapeworms of the dog (*Taenia coenurus*), which becomes located on the surface of the brain and spinal cord of the sheep. The increased pressure produced on the brain and spinal cord by the presence of the capsules in which the worms are found causes the nervous symptoms which characterize the disease. The chief symptoms are the persistent turning around, loss of appetite and emaciation. In cases where the tapeworm is located on one side of the brain, a tendency of the animal to turn its head to one side is more or less marked. Sometimes, when the worm is located near the top of the head, an enlargement of the skull over this point takes place, and the worm may be removed by an opening through the skull. The adult form of the tapeworm infests the digestive organs of dogs, wolves, coyotes and foxes, and the eggs escaping along with the feces are washed upon the stems and roots of grasses, and thus may be taken into the stomachs of sheep, from which position, by boring their way through the tissues, some of them come to be located upon the brain and spinal cord. No medicinal treatment is of any value against the disease. When the worm may be definitely located it may be removed by trephining.

In preventing this disease attention should be given to burning and burying the spinal cord and brains of sheep which have died of gid. Dogs should not be allowed in sheep pastures without treatment for tapeworms. Gid is fortunately not very prevalent in this country.

Foot Rot. In general 2 forms of this disease are recognized, the non-contagious and the contagious. Some veterinarians, however, consider them both the same, differing only in degree of virulence. The non-contagious form is believed to be produced by foreign substances between the hoofs, causing inflammation of the space between them. If this inflammatory process is not checked the whole foot becomes involved and the horny layer separates and falls off. The same result is sometimes brought about by moving sheep from high to low marshy pastures. Under such conditions the hoofs grow too long and offer better opportunity for the adherence of materials which cause inflammation and decay. Usually the front feet are worst affected. In treating this disease superfluous horn should be removed from the hoof, the feet should be cleaned thoroughly, and butter of antimony applied to the inflamed part. The application should be repeated in 24 hours if the wound is still discharging. The foot may be kept clean by washing with water containing blue vitriol 1 part to 12. One part of carbolic acid to 100 of water may be used for the same purpose. In the contagious form the cause is thought to be a virus which may be introduced into the flock in various ways from infected sheep. Lameness is noted in one or more feet. Affected feet will be found swollen above the hoof and the spaces between the claws will be red and sensitive.



KARAKUL SHEEP PELT

Botfly (*Oestrus ovis*) resembles somewhat the common housefly, but is covered with small round spots. The abdomen bears velvety brown and straw colored hairs. The maggots of this species are of a white color, with brown spots on the posterior segment. The eggs are deposited

by the adult fly within the nostrils of the sheep. After hatching, the larvae penetrate deeply into the nasal cavity, and after becoming full-grown fall to the ground, where they bury themselves and finally emerge as adult flies. The maggots may sometimes be dislodged by means of a feather dipped in turpentine and inserted into the nostrils of the sheep. Fumigation by means of sulphur fumes and other irritating substances in closed rooms has proved injurious to the sheep and only partly effective for removing the maggots. Tar smeared about the nostrils of sheep has a tendency to prevent the flies from laying their eggs in them.

LUNG and STOMACH WORMS are small round worms belonging to the genera *Strongylus* and *Haemonchus*, of which a number of species are found in the lungs and respiratory passages, while *H. contortus* is parasitic in the stomach. The parasitism of lung worms in the sheep is characterized by fits of coughing and sneezing, with a mucous discharge from the nostrils. The sheep stretch out the neck, rub the nose on the ground and give evidence of difficulty in breathing. Diarrhea is usually present. The wool becomes loose and the skin is pale, from which the popular names white-skin and paper-skin are derived. Lambs are most subject to the disease during the first year.

In case of parasitism of sheep by the stomach worm, there are digestive disturbances, accompanied by constipation and later diarrhea. The appetite is irregular and abnormal. In the treatment for the stomach worm of sheep a good remedy is 1 part of turpentine to 16 parts of milk, given in doses of from 1 to 3 tablespoonfuls, according to the size of the lamb. Better results are obtained from the use of a mixture composed of 8 parts pine tar, 8 parts raw linseed oil and 1 part turpentine, in doses of 1 to 3 ounces. The most satisfactory treatment for stomach worms is a 2 per cent solution of copper sulphate in water in doses of 3 ounces for yearlings and 1½ ounces for lambs 3 months old. Since infection comes chiefly from eating grass to which the stomach worms are clinging, prevention consists in frequent change of grazing ground as mentioned under *Pasture*.

FRINGED TAPEWORM (*Taenia fimbriata*) is the cause of extensive financial loss in sheep, especially in the Western States. When these worms are present in the intestines and bile ducts of lambs in large numbers, the lambs are weakened and fail to develop and put on fat. The general symptoms are those of malnutrition, and by some authors are considered nearly identical with the symptoms of loco disease. The worm produces first an irritation of the intestines, and their presence in the gall ducts produces similar results and obstructs the flow of bile. Vermifuge treatment is usually without very satisfactory results.

LIVER ROT is due to the presence of a flat worm which is parasitic in the liver, lungs, abdominal cavity, or rarely in the muscles of sheep, cattle, hogs and other domestic animals. The adult is found in the bile ducts of the liver, where it produces a great number of eggs. These eggs pass into the intestines, from which they are eliminated along with the feces. Such eggs as find their way into ponds and pools of water hatch and are parasitic in the body of fresh-water snails. After passing this immature condition they crawl upon the stems of grasses, from which position they may be taken into the stomach of sheep or other animals and attain again the adult condition in the liver of such animals. The symptoms of the disease produced by the liver fluke are not well defined. In sheep there is usually a redness of the eyes, which soon yields to a paleness and general bloodless condition, followed by emaciation and a rapid respiration. The mortality from this disease is high. It is frequently the cause of trouble in cattle, but is comparatively rare in hogs. The fluke disease is more prevalent in wet than in dry years. A dose of 1 cc. of carbon tetrachloride is very effective.

SHEEP TICK (*Melophagus ovinus*) has frequently been considered of little importance as an enemy of the sheep. This insect is a peculiar fly, without wings and with only 6 legs, differing in this respect from the true ticks, which have 8. The sheep tick is really the cause of serious losses among lambs in many localities. After the ewes are shorn the ticks migrate at once to the lambs and cause great irritation and loss of flesh. It has been found necessary in many localities to dip the whole flock, including lambs, immediately after shearing, in order to get rid of this pest. For this purpose sheep may be dipped in the same solutions as used for sheep scab.

BLOATING. *See* under *Beef Cattle*.

Dogs and Sheep. Dogs are almost indispensable companions and assistants to the Western sheep herder, and also among the worst enemies with which the Eastern sheepman must contend. Sheep-killing

dogs have become the subject of legislation in almost every State and still cause heavy annual losses. Beside their direct attacks on sheep, dogs are hosts to several parasites which live in one stage in sheep. Stray dogs in sheep pastures are, therefore, a possible danger in these two ways.

GOATS

The goat is a familiar animal about the farmstead in every State but is commonly looked upon as of little more importance than the guinea hen or peafowl. The very name Angora takes one in thought to Turkey whence that breed was first imported in 1850, and few persons are aware of the development of the Angora goat industry in the U.S. There are 3,298,000 Angoras in this country, of which 2,723,000 are in Texas and most of the others are in New Mexico, Missouri and Oregon.

The Angora provides us with meat and mohair. The meat, under various names such as chevon, Angora venison, Angora mutton or plain mutton, is of good flavor. Many consider it equal to mutton. Others speak of a sweet tang. Even in the Southwest, where consumers are most familiar with it, Angora mutton sells for less than sheep mutton.

Our annual production of mohair has reached 15,000,000 pounds. Mohair is used chiefly in robes, rugs, braids, upholstering and linings for men's summer suitings. Our manufacturers now find the domestic production of mohair adequate for their needs.

Angoras seem to thrive best on brush land, and require rather more freedom of ranging than sheep. They naturally travel farther than sheep in search of their daily provender, feeding on the leaves and buds of a great variety of brush and weedy growths. This habit has resulted in their wide use for clearing brush from cut-over lands and thus preparing these areas for agricultural purposes. Texas has opened the opportunity for a large goat industry by virtue of its possession of immense areas of cheap brush lands with dry climate at altitudes of 1000 to 2000 feet.

ANGORA GOATS

In the Southwest the Angora yields an average of 3½ to 5 pounds of mohair annually, taken off in 2 clips. In northern areas only one shearing a year is necessary. Practically all shearing is done by machines. The value of the mohair depends on its length and fineness. It should be 6 inches long and free from kemp. In warm climates the Angora exhibits a tendency to shed the hair in the spring. This makes it desirable to shear them just before the kidding season and again in August.

In Missouri and in the Northwest where the effectiveness of goats in clearing brush lands is generally understood, goat owners sometimes rent their goats to farmers who have the problem of eradicating shrubby growth from potentially tillable areas.

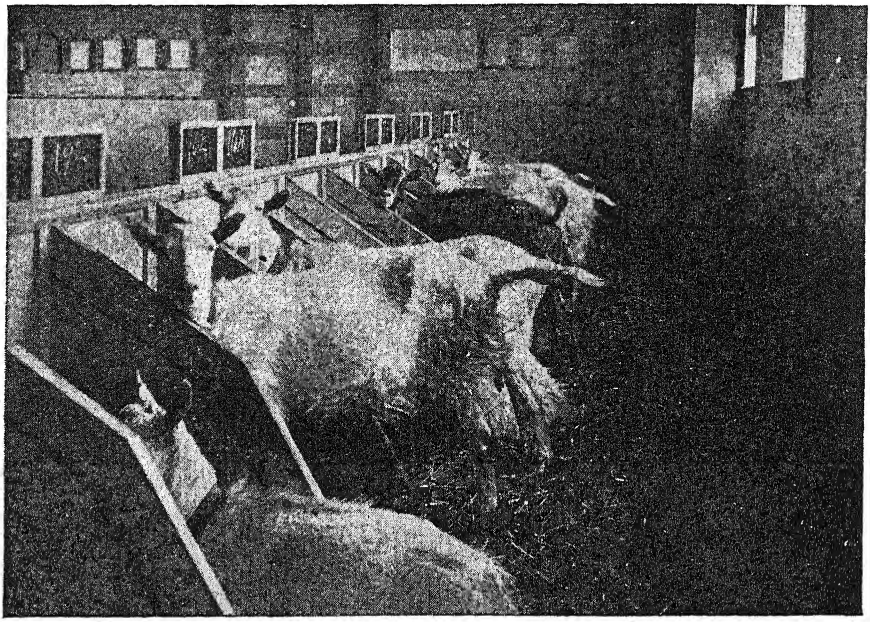
From 2 to 5 goats per acre are usually sufficient to accomplish the task.

In European and Asiatic countries goats have been reared for milk production since the beginning of time. Goat dairying has never been an important industry in the U.S. Goat's milk has a smaller percentage of total solids than cow's milk. The content of fat, casein and milk sugar is less than in cow's milk. The vitamin content and the nutritive value are not much different from those of cow's milk, as shown by many tests in infant feeding. Tuberculosis is extremely rare in goats. Unfortunately some of the early importations of milch goats were infected with Malta fever.

Milch goats of good stock, such as the Toggenburg or Saanen breeds yield from 2 pints to 3 quarts of milk per day. Naturally the feed requirements of goats are so slight that suburbanites so disposed could easily maintain a goat on an area where a cow would be out of the question. Goat's milk may, and has been used, for all purposes to which cow's milk is adapted, but is not so suitable for making butter. In New Jersey and elsewhere, hard cheese and cottage cheese have been made from goat's milk, and desiccated goat's milk is on the market. Around several cities, particularly in Texas and the Southwest, there are quite pretentious goat dairies that supply the growing demand for goat milk.

The proper care and management of milch goats is very much the same as for sheep. Like sheep they do not thrive on wet, swampy land. Like sheep they are susceptible to lung and stomach worms. The lactation period is 7 to 10 months. On account of the small size of goats it is customary to milk them on a stand 18 to 30 inches high. Goats may be milked from between the legs or from the right side. The kids may be allowed to suck the dams till weaning time, or may be taught to take milk from a bottle with nipple, by a gradual change from goat's milk to cow's milk. At the end of 10 weeks the milk may be mostly replaced by hay and grain. The kids of milch goats, when slaughtered at 2 or 3 months of age provide a very palatable meat. The owners of milch goats have requests from time to time for the temporary loan of a doe to provide milk for some special dietary case.

Goats are probably less troubled by diseases than are sheep, but the diseases to which they are subject are the same as afflict sheep and require the same preventive and remedial treatment.



MILCH GOATS IN STABLE

VETERINARY MEDICINES

In administering drugs to domesticated animals the most convenient and practical methods for use of stockmen are by drenches, in the form of powder or solution upon grain feeds, or in hypodermic injections. The use of capsules is not so generally practiced among farmers, but drugs may be easily administered in this manner by veterinarians. Drenches may be given in several ways. Round-neck bottles, horns, rubber tubes connected with bottles, and special devices made for the purpose, may be used according to circumstances and convenience. All drugs which are somewhat irritant in their pure form should be mixed with meal or dissolved in a sufficient quantity of water to render them harmless.

Medicines are usually divided into a number of classes according to their action or physiological effect. A few only of these classes can be mentioned in this connection.

Antiseptics are substances which prevent or check the growth of bacteria which cause putrefaction or disease. The most common antiseptics are table salt, carbolic acid, corrosive sublimate, formalin, iodoform, zinc chlorid, iron chlorid, etc.

Disinfectants and deodorizers are used for similar purposes and also to absorb moisture and disagreeable odors which may have been developed. Permanganate of potash, sulphurous acid and chlorid of lime are examples of this class of drugs.

Vesicants are blistering agents. Common drugs of this class are cantharides or Spanish fly, croton oil, strong acids, silver nitrate, butter of antimony, etc.

Purgatives, also known as laxatives or cathartics, are drugs used for the purpose of producing a loose condition of the bowels. In veterinary medicine the drugs most used for this purpose are Glauber salts, Epsom salts, aloes, castor oil, jalap and croton oil.

Tonics are of a class of drugs which have a tendency to improve the appetite and increase the vigor of the animal. This term may also be used in a broad sense to include stimulants. The common drugs included under this class are quinine, sulphate of copper, sulphate of iron and copper, ammonia, alcohol, ether, etc.

Alteratives are drugs which neutralize or counteract the formation of disease products or processes in the blood. The most frequently used alteratives are iodin, arsenic and various salts.

Narcotics constitute a class of drugs of which the effects are too well known to require description. In veterinary medicine opium, Indian hemp, belladonna, and chloral hydrate are most frequently used for the purpose. The following brief notes may serve to indicate the doses and action of some of the more common drugs used in veterinary practice.

Aconite lowers the temperature, weakens the pulse and causes sweating. Dose for horses 20 to 30 drops, for cattle 30 to 40 drops, for sheep 3 to 5 drops.

Aloe (Barbadoes) is a purgative and is generally administered to horses. Dose for a horse 4 drams, for a dog ½ dram.

Aromatic Ammonia is a stimulant and an antidote for acid poisons. Dose for a horse 1 to 2 ounces, for cattle 2 to 4 ounces, for sheep ½ to 1 dram. Locally it acts as a blister.

Areca Nut is used as a vermifuge. Dose for horses, cattle and asses 1 ounce, for sheep 3 drams.

Arsenic is an alterative and nerve tonic. Dose for horses 5 grains, for cattle 5 to 8 grains, for sheep 1 grain.

Bismuth (Subnitrate) coats the walls of the stomach and intestines and soothes irritation. Dose for horses 2 drams, for sheep 20 grains, for dogs 5 to 10 grains.

Bromid of Potash lowers the temperature slightly and checks nervous excitement. Dose for horses 2 to 4 drams, for sheep ½ dram, for dogs 5 to 10 grains.

Calomel is a strong cathartic. Dose for horses 1 dram, for cattle 1 to 2 drams, for dogs 3 to 4 grains.

Cantharides used locally is a strong blistering agent. Given internally it is a stimulant. Dose for horses 5 grains, for cattle 5 to 10 grains, for sheep 1 to 2 grains.

Carbolic Acid is chiefly used as an antiseptic and disinfectant. For ordinary purposes it should be used in a solution of water in the proportion of 1 part of carbolic acid to 100 parts of water.

Castor Oil is a mild purgative. Dose for horses 1 pint, for cattle 1 to 1½ pints, for sheep ¾ ounce, for dogs ½ ounce.

Catechu is an astringent. Dose for horses 2 to 5 drams, for cattle 3 to 8 drams, for sheep 1 to 2 drams, for dogs 10 to 30 grains.

Chloral Hydrate is a powerful narcotic and especially valuable in the treatment of spasmodic colic. Dose for horses 1 ounce, for sheep 2 to 3 drams, for dogs ½ dram.

Corrosive Sublimate is a voilent poison much used as an antiseptic. For ordinary purposes it should be used in a

solution in the proportion of 1 part of corrosive sublimate to 1000 parts of water.

FORMALIN is a non-corrosive, non-poisonous antiseptic of great value, its chief disadvantage being its irritating effect on the eyes and nose. For ordinary antiseptic purposes, such as the treatment of wounds and disinfecting instruments or receptacles, it may be used in a 4 per cent solution in water.

GENTIAN is a bitter tonic. Dose for horses 4 drams, for cattle ½ to 1 ounce, for sheep ½ dram, for dogs 10 to 20 grains.

GINGER is used as a stimulant and stomachic. Dose for horses 1 ounce, for cattle 2 ounces, for sheep ½ ounce.

INDIAN HEMP is a narcotic and much used, like chloral hydrate, in spasmodic colic. Dose for horses ½ to 1 dram, for sheep 10 to 15 grains, for dogs 1 to 2 grains.

IODID OF POTASH is used as an alterative in the treatment of various infectious diseases, such as big jaw, for which it is a specific. Dose for horses ½ dram, for cattle 1 to 2 drams.

JALAP is a purgative most used for the smaller domesticated animals. Dose for hogs 1 to 2 drams, for dogs ½ to 1 dram.

IRON PEROXID, SULPHATE OF CARBONATE are used as general tonics. Dose for horses 2 to 4 drams, for sheep ½ dram, for dogs 2 to 5 grains.

LIME WATER is an astringent and antidote for acid poisoning. Dose for horses 4 to 5 ounces, for cattle 4 to 8 ounces, for sheep 1 ounce, for dogs 1 dram.

LINSEED OIL is commonly used as a laxative. Dose for horses 1 to 2 pints, for cattle 1 to 2 quarts, for sheep ½ pint.

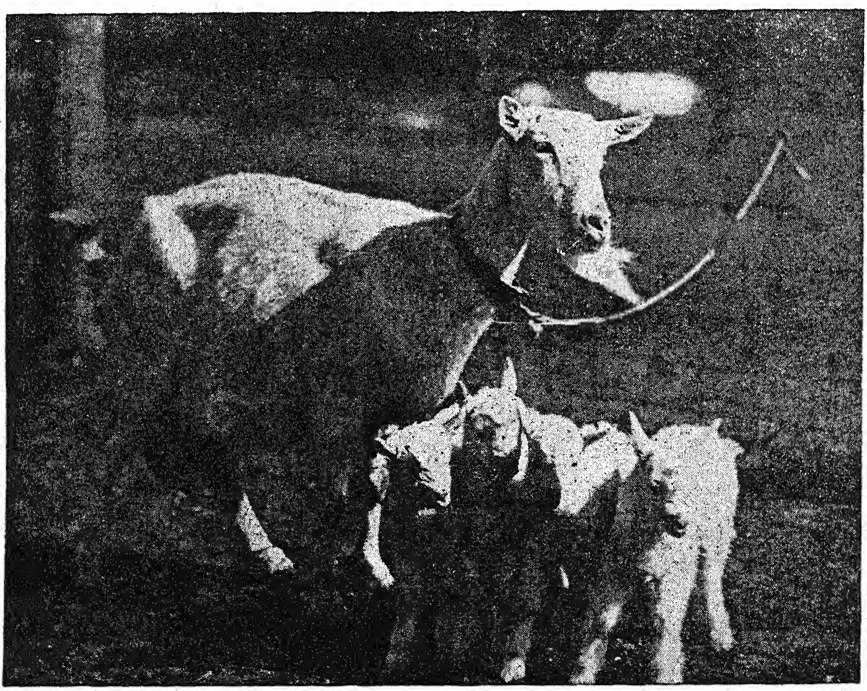
OLIVE OIL is used like linseed oil. Dose for horses 1 to 2 pints, for sheep 3 to 6 ounces, for dogs 1 to 3 ounces.

OPIUM is used as a narcotic for the prevention of spasms. Dose for horses ½ to 2 drams, for cattle 2 to 4 drams, for dogs ½ to 3 grains.

QUININE is a bitter tonic and most used in diseases accompanied with fever. Dose for horses 20 grains, for cattle 20 to 30 grains, for sheep 6 to 10 grains, for dogs 2 to 6 grains.

SULPHATE OF SODA OR GLAUBER SALTS is a purgative. Dose for horses 1 to 1½ pounds, for cattle 1 to 2 pounds, for sheep 2 to 6 ounces.

SWEET SPIRITS OF NITRE acts as a stimulant, lowers the temperature and causes



MILK GOAT WITH QUADRUPLETS

sweating. Dose for horses 1 to 2 ounces, for cattle 3 to 4 ounces, for sheep 3 to 6 drams.

TINCTURE OF IODIN is frequently used in external applications to check local inflammation and as treatment for certain skin diseases. It may be painted on the affected parts with a brush.

ZINC CARBONATE and SULPHATE are used as astringents and tonics. Dose for horses 2 drams, for cattle 2 to 4 drams, for sheep ½ to 1 dram.

USE. For the use of various medicines mentioned *see* under the diseases of *Cattle, Chickens, Dog, Horse, Swine, Sheep, Turkey, etc.*

CASTRATION

This is an operation which the farmer is frequently called upon to perform. A few suggestions may therefore be given as to methods in castrating the stallion, bull, buck, boar and other male animals. Large animals may be held by throwing with rope or by the use of a chute.

The male calf, if not to be kept for a bull, should be castrated at the age of 2 or 3 months. An incision should be made through the scrotum so as to expose the testicles, which should be removed one at a time after cutting or preferably crushing off the spermatic cord by twisting, or by the use of clamps, ligature, or an ecraseur. In young animals there is little hemorrhage, but in old bulls the spermatic artery must be crushed off or held by a clamp in order to prevent bleeding.

Male colts should be castrated at about 1 year of age, or a little later if a larger build is desired. A cut should be made through each side of the scrotum parallel with the middle line. The testicle is then forced through the opening and the posterior half of the cord is cut off with a knife. This is the muscular part of the cord and severing it prevents the animal from exercising any further strain on the testicle. The testicle now hangs limp and the remainder of the cord may be cut off after applying clamps or by crushing with an ecraseur.

If boar pigs are castrated at the age of 1 or 2 months, or before they have seen any service, the operation may be safely done by exposing the testicle and cutting off the cord with one stroke of the knife. In old boars excessive bleeding may be prevented by crushing off the cord or applying clamps.

Lambs may be castrated at the age of 10 days or 2 weeks by cutting off the tip of the scrotum, pressing out the testicles and cutting them off with 1 stroke of the knife, or by biting them off with the teeth, as is the usual custom with Western sheep ranchers. No further precautions are necessary. Young goats may be castrated in the same manner.

Veterinary textbooks usually recommend that the scrotum and surrounding parts be carefully washed with some antiseptic solution and that the hands and instruments be similarly cleansed before the incision is made. The busy farmer seldom has time for these preliminary operations and bad results need not be feared when ordinary cleanliness is observed. It is well to have some powdered antiseptic such as iodoform in a tin box with a perforated top. A little of the antiseptic may be quickly dusted into the scrotum immediately after the removal of the testicles.

In all animals the incision in the scrotum should be made lengthwise of the animal, parallel with and at a short distance from the middle line. The incision should be at the lowest point of the scrotum, and this corresponds to the point of greatest tension when the testicle is forced down by pressure with the hand.

The operator should be careful not to pull the cord. Peritonitis and death may result from such strain, especially in colts. The cord should always be cut short enough so it will not hang through the cut in the scrotum. If clamps or ligatures are applied to the cord, they should be removed after about 24 hours.

PART VI

POULTRY

BRONZE TURKEYS AT PASTURE

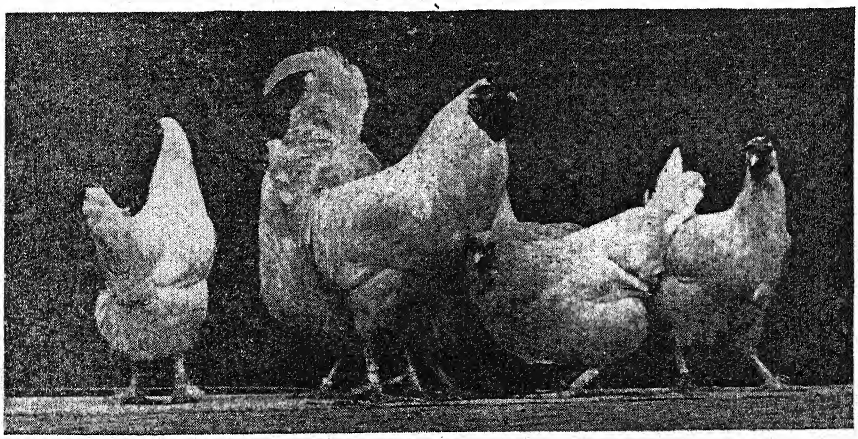
POULTRY

In many respects the poultry industry presents a picture differing from that of other lines of live stock enterprises. In the first place it is concerned with creatures of small size as compared with other farm animals. It deals with birds instead of mammals. The processes of digestion take place much more rapidly in a chicken than in a cow. All physiological activities are correspondingly rapid. Body temperatures and pulse rate are higher. Reproduction requires much less time, 21 days in the case of the hen, as contrasted with the long period of gestation in the mare or cow. Moreover, poultry raising has been, and still is, considered as an incidental feature of farming, a side line which might well be left to the care of the women of the household. And so it might, for it is an occupation peculiarly suited to women, demanding as it does close observation of the behavior of the fowls and the most meticulous attention to the sanitary condition of the poultry house, the cleanliness of the drinking fountains, feed troughs and yards, temperature of the brooder houses and countless other details directly involved in the welfare of the fowls.

But the volume of the industry is not measured by the size of the hen. There are at present about 474 million chickens in the U.S. distributed among 5,225,000 farms, with an output of over 2 billion dozen eggs annually. Then there are turkeys, ducks, geese, guineas and pigeons to consider. Poultry raising is, of course, by no means exclusively in the hands of farm wives. In most States large poultry farms, up to 5000 acres or more, have developed the enterprise into a strictly commercial venture. In one instance at least a whole ship's cargo of eggs not over 4 days old were collected in Petaluma, California, and neighboring localities, and loaded aboard ship in the Golden Gate for export.

CHICKENS

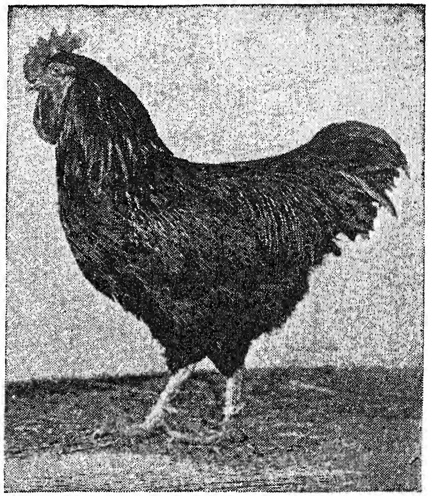
So long as and wherever the farm flock is a small one, designed solely to furnish eggs and meat for the family, the chickens are left much to their own devices. They are allowed to range about the yard, nearby fields and orchards in search of seeds, fruit, insects and such other food as they may chance upon. Under these conditions chicken houses provide some protection from the weather, also roosts and nesting boxes, and the dirt floor is usually covered with straw or corn husks which are removed occasionally when they have become foul enough to be thrown on the manure pile. Later, when the farmer



WHITE PLYMOUTH ROCKS

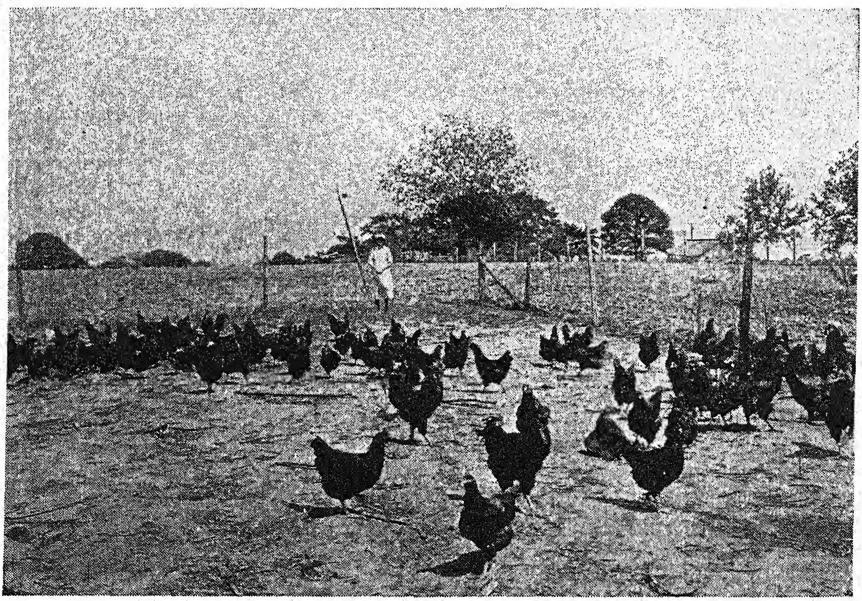
or farmer's wife saw a source of weekly income in poultry, the flock was enlarged and the solution of the housing problem could no longer be left to chance. If the number of laying pullets were swelled to 300 the danger from diseases in crowded unsanitary quarters came to the fore.

Plans for chicken houses are legion. Practically every State Experiment Station has worked out a suitable style and arrangement of structure to meet local conditions. Such architectural blue prints or descriptive details in bulletin form may usually be obtained from your County Agent. The type of house is not so important if it contains the features of design that are essential to proper sanitation. Floors and foundations should be impervious to moisture, have a smooth hard surface easily cleaned, and be proof against rats and other vermin. Concrete answers those specifications best. Dirt floors can neither be cleaned nor disinfected. Wood floors are difficult to clean. Rats and vermin find shelter underneath. Insects and disease-bearing bacteria accumulate in the cracks. Walls should be constructed of matched lumber so closely fitted that ticks and lice can find no lodging places. All openings to admit ventilation should be covered with wire screen to exclude wild birds, bats or insects. Abundant provision for sunlight must be made. If dropping boards are installed the fowls must be kept from coming in contact with them by means of wire netting under the roosts. If dropping boards are not provided the litter must be changed more frequently.

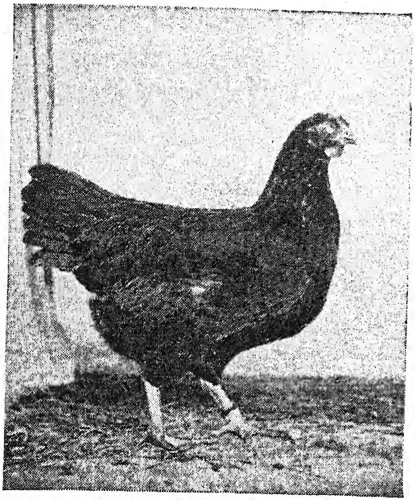


RHODE ISLAND RED MALE

The rate of growth of the chicks will show whether the housing and feeding facilities are conducive to satisfactory results. At hatching time a chick weighs about 1¼ ounces, at 2 weeks double that,



RHODE ISLAND REDS



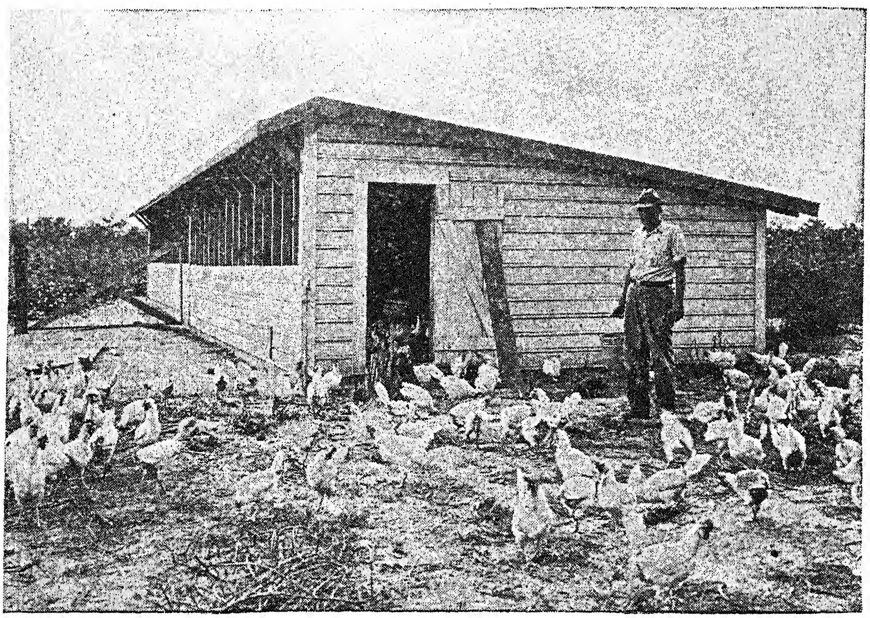
RHODE ISLAND RED FEMALE

at 4 weeks double again, or 8 ounces, and at 6 weeks 1 pound. Chicks that lag behind that schedule are for one reason or another not up to standard. In Oklahoma it has been found that the needful equipment for a flock of 300 hens is an open front house 20 x 70 feet, providing 3 rooms each 20 x 20, and 1 room 10 x 20 for feed and service, also 2 brooder houses 12 x 16 floor size. A brooder house of that proportion could hold 500 chicks but 350 would be a safer allowance. At any stage of the chicken's life from hatching to laying maturity there is danger from overcrowding.

In starting a poultry enterprise the breed to be chosen is a matter for each farmer to decide. If the beginner has a preference in the colors of eggs he should remember that the Leghorns, Spanish, Minorca, Andalusian and Hamburg lay white shelled eggs, while Plymouth Rock, Wyandotte, Rhode Island Red, New Hampshire Red, Orpington, Langshan, Brahma, Cochin, etc. lay brown eggs. There are more than 80 varieties from which to choose, grouped into 4 classes—American, Asiatic, English and Mediterranean. Some breeds are more noted for meat production than for egg laying. Breeds of the American Class have yellow shanks free from feathers. The Asiatics are large and have feathered shanks. The standard weight of the Light Brahma

FARM FLOCK OF RHODE ISLAND REDS

cock, for example, is 12 pounds. The Mediterranean Class, including Leghorns and Minorcas, are kept primarily for egg production, lay white eggs and are non-brooders. Whichever breed selected should be the only one on the farm, if the venture is to be commercial. Plymouth Rock, Wyandotte, Rhode Island Red, New Hampshire Red and Brahma are widely distributed. For egg production the White Leghorn is the preferred breed. There is room in this connection for only the briefest notes on the characteristics of a few of the most familiar breeds.



HIGH LAYING WHITE LEGHORNS

PLYMOUTH ROCK is to be had in 7 varieties of different color patterns, the barred variety being perhaps the best known, is an excellent meat fowl and a good layer.

WYANDOTTE, with 7 or 8 color patterns from which to choose, is also a good dual purpose chicken. The body appears rounder and the back shorter than in the Plymouth Rock.

RHODE ISLAND RED is somewhat smaller than the Plymouth Rock, with rich red plumage, long body and upstanding appearance. It is a general purpose fowl, meaty, and produces a weight of eggs equal to that of the Leghorns though perhaps fewer in number.

NEW HAMPSHIRE RED, a relatively new development from the Rhode Island Red, is chestnut red in color, of much the same form as the Rhode Island Red, with deep breast. This breed gives promise of being a large egg producer, while comparing favorably with the breeds just mentioned for meat.

BRAHMAS, LIGHT, DARK or BUFF, are heavy birds, the Light variety weighing most. It has a pea comb and white and black feathers on the shanks and toes, and is primarily a meat breed.

COCHIN, characterized by massive appearance and feathered shanks, occurs in several color patterns—buff, partridge, black and white.

ORPINGTONS (buff, black, white and blue) are characterized by long deep body and broad back, single comb and pink shanks. They are excellent meat fowls and fairly good layers.

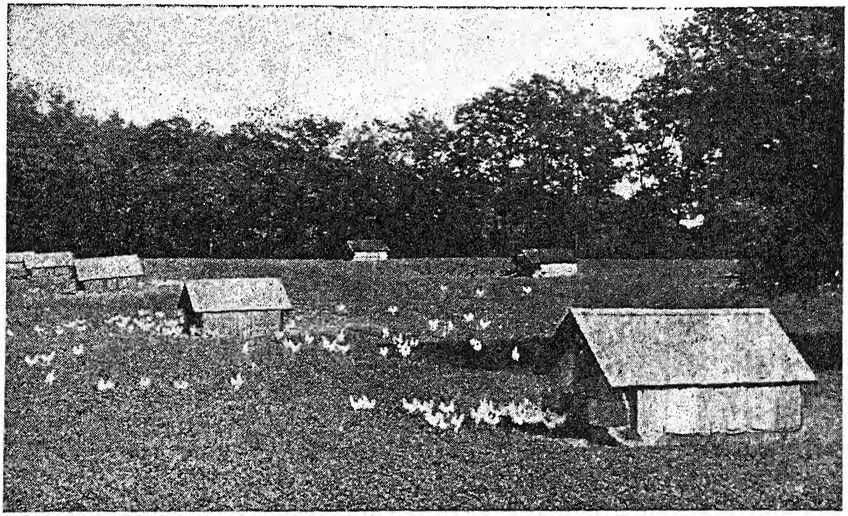
LEGHORNS, with a dozen color varieties, are smaller than the breeds mentioned above, are noted for graceful symmetry of form and stylish carriage. There are both single and rose-combed Leghorns. The shanks are clean and yellow. The white variety seems to be the favorite breed of commercial poultrymen.

Layers and Non-Layers. How to distinguish between layers and non-layers is a matter of prime importance. Careful

research by such geneticists as J. P. Quinn and others has shown that there is little or no basis for the belief that there is an egg-laying type of hen. Neither body conformation, wedge shape, weight of brain, shape of head, length of body nor other live or carcass measurements give any reliable guidance in picking layers. The color and size of the comb and wattles indicate the relative size of the ovaries. "When a pullet is about to lay she has a large bright red comb and smooth full wattles. When production stops the comb shrinks, becomes dull, dry and shriveled." The small round vent of the pullet enlarges and becomes oval during the egg-laying period, the pubic bones spread farther apart and the abdomen expands as the distance between the keel and pubic bones increases. According to Census figures the average egg production is 90 per hen. A 100-egg hen yields only a bare profit. There are many flocks that average 150 to 200 eggs annually per hen. An average of 150 eggs is a reasonable goal at which to aim.

About 70 per cent of the pullets in most flocks will lay 20 per cent fewer eggs the second year than the first. The common practice is to retain only about 30 per cent of the pullets for the second year. But some hens continue to be heavy layers for 3 or even 4 or 5 years. Thus in recent tests in New Jersey 109 out of 1431 White Leghorns laid 225 or more eggs the first year, 170 the second, 150 the third and 130 the fourth year. Rhode Island Reds in the test showed the same tendency to sustain production. One Rhode Island Red hen made a record of 279, 232, 219, 150 and 168 eggs during her five laying years, a total of 1048 eggs. Since the average cost of rearing a pullet to the laying age is about $1 it will pay to retain those that promise a longer active life.

The vitality of chicks and the egg capacity of pullets are in large part inherited qualities. Heredity may be as important a factor in success with poultry as are feed, housing, sanitation and management. In one experiment in New Jersey White Leghorns were less susceptible to fowl pox, black head and coccidiosis than were the Rhode Island Reds.



GRASS RANGE FOR CHICKENS

In the production of eggs the yellow pigment in the skin, beak and shanks is translocated to the yolks of the eggs. The degree to which the yellow has faded and the skin and other parts paled, is a good indication of the extent of egg production.

The hen that stops laying in June and begins to molt is a poor layer. She may be 4 to 6 months in the molting process and therefore out of production from June to December. Late molters may take only 2 or 3 months' rest and start laying again in December or January.

The degree of broodiness is another point in judging laying capacity. At the Beltsville Experimental Farm the produc-

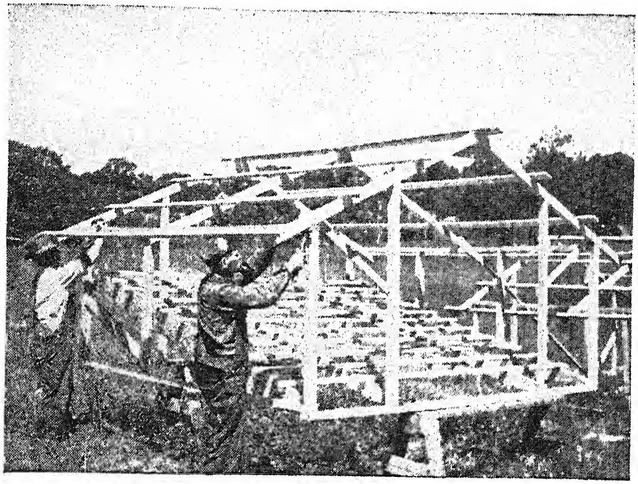
tion of non-broody White Leghorns was 194 eggs as contrasted with 153 eggs for the broody ones. In general hens that keep on laying into August and Septmber are well worth keeping. Active laying in April and May is no indication of egg capacity in a hen. Any hen may lay in April.

Green vegetable matter is an essential part of the diet of poultry. It may be supplied either by cutting and feeding to the fowls confined in poultry houses or by permitting the birds free range out of doors. Both methods have stanch advocates. D. C. Kennard of Ohio argues that "the range with good pasturage is the best

BANDING BREEDING STOCK

Poultry Diet. Where the small family-size flock is allowed to range at large about the farm no consideration need be given to the question of vitamins in the hens' diet. They may not lay more than 75 to 100 eggs a year, and anyhow lead an easy natural life. But in commercial operations, where each hen is looked upon as an egg factory and judged accordingly, attention must be directed sharply to the diet. When diet is deficient in vitamin A a sort of roup or coryza develops with watery or bleared eyes. Fresh greens, alfalfa meal, yellow corn or fish oil should then be added to the ration. Vitamin D deficiency results in rickets and indicates that the fowls are not receiving enough sunshine.

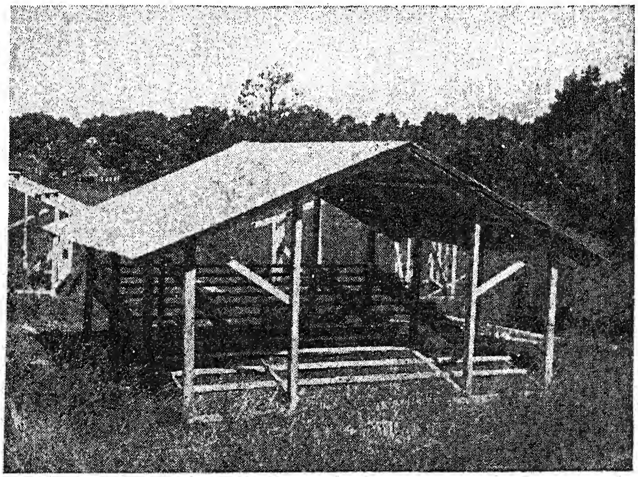
and most economical way to provide vitamins A, D, and G for feeding chicks and growing pullets, for the sunshine and green feed provided by a good range permit omission of the special carriers of these vitamins." The Ohio Station recommends a special mash to be fed to chicks during the first 7 or 8 weeks, and a range ration for growing pullets, designed to supplement the vitamins not adequately provided by the range pasturage, which in this case included clover, alfalfa, rape and blue grass. The clover and blue grass had to be mowed to prevent them from growing too tall. From 200 to 300 pullets were raised on an acre of pasture.



SHELTER BUILDING

Confinement of Poultry. In the Southwest, where sunshine and dry soil tend to prevent poultry ranges from becoming contaminated with diseases, it is not vital to provide all the facilities required for keeping poultry permanently in confinement. The Oklahoma Station concludes that "chicks can be grown for 6 to 8 weeks in the brooder house and on the sunporch in confinement. With care pullets can be raised to maturity in confinement. This is not necessary in Oklahoma and should be done only as a last resort on badly contaminated farms."

But poultry can be successfully raised in confinement when provided with ample room for exercise, sunshine, ventilation and adequate diet. The nutritive value of alfalfa, clover, lettuce, rape or cabbage is the same whether eaten out of doors or in a hen house. Rearing poultry in confinement, however, at once brings forward the problem of sanitation. Eggs, day-old chicks or fowls of any age, should never be added to the flock, or brought into the hennery, unless they come from disease-free premises. Eternal vigilance is the price of healthy fowls. Among cleansing and disinfecting agents sunshine should not be forgotten. Concrete floors may be sterilized by a blowtorch. But the flame should be moved slowly enough to allow

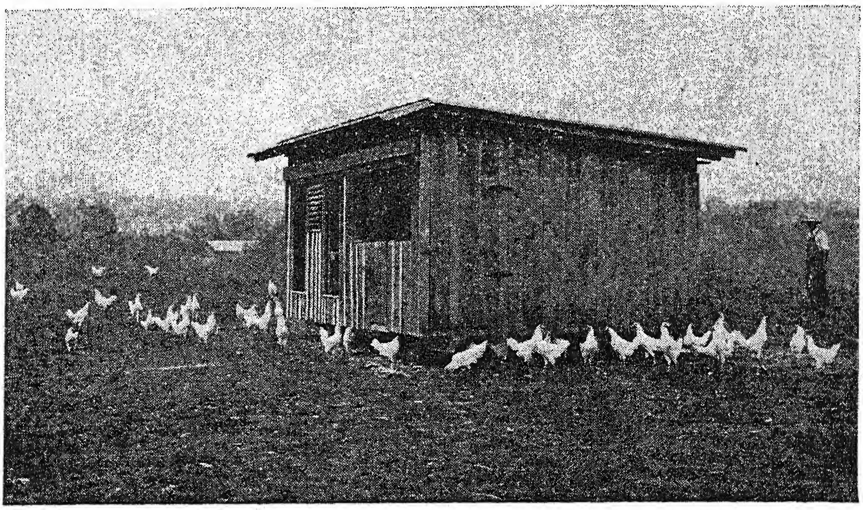


COMPLETED SHELTER

about an hour for every 180 square feet. Cresol, saponified cresol solutions, iodine suspensoid, chloride of lime and lye are satisfactory chemical disinfectants. Potassium permanganate added in sufficient quantity to water to give it a wine color is non-poisonous and renders the drinking water safe. Kerosene emulsion or paraffin-oil emulsion or crude petroleum sprayed on walls or other wood work, will penetrate cracks and exterminate lice and ticks.

Rations. Innumerable experiments have been carried on in the various States in trying to arrive at an ideal feeding program for fowls. In these tests every feed material that a hen would eat has been tried. Each kind of grain has been compared with other grains for relative efficiency. Feeds of plant and animal origin, pasture crops, chopped hays, carbonaceous and nitrogenous materials have been under experiment time and time again. In these tests scores of different mixtures have proved satisfactory. There is no single ideal ration for poultry. Indeed the Pennsylvania Station concludes "that much of the concern evidenced about exact feeding procedure might be transferred to other management problems, assuming that any feeding procedure chosen by the poultryman has, as its main objective, the maintenance of a constant high level of total feed consumption of a well balanced mash and sensible grain mixture or individually fed grains." A very close relationship was found between feed intake and the number of eggs laid. This rather than the maintenance of a fixed balance between grain and mash appears to be the critical factor. In Pennsylvania a 31 per cent protein mash was equal but not superior to an 18 per cent mash, fed with the same grain mixture.

Opinions have differed on the question whether all constituents of the ration should be mixed together in a theoretically correct proportion or provided separately for the fowls to choose the different feed materials at will. On this point an interesting observation was made in Ohio in experiments with Leghorn and Rhode Island Red pullets. "A marked variation in the proportion of whole grain, ground grain, middlings and bran did not noticeably affect the value of the ration for layers. This finding permits more liberal use of whole and ground grain when middlings and bran are higher priced.



MOVABLE BROODER AND LEGHORN PULLETS

"Ground grain has no advantage over whole grain for layers.

"The Leghorn and Rhode Island Red pullet layers precisely balanced their rations as to proteins, minerals and vitamins when given the free choice of whole corn, oats and a suitable 24 to 32 per cent protein mash supplement.

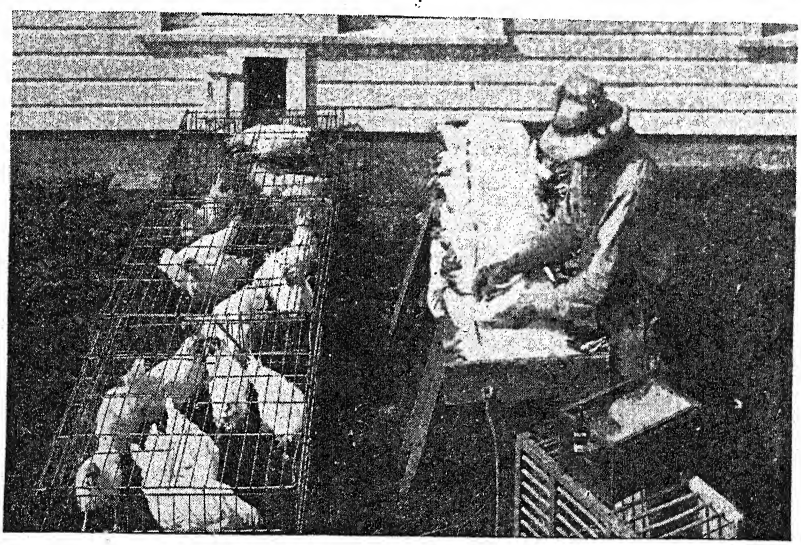
"The use of a suitable 32 per cent protein mash supplement and the free choice of whole corn and oats requires mixing or purchasing of only 20 to 25 per cent of the total feed and dispenses with the need and cost of grinding together.

"The protein, mineral and vitamin re-

quirements of individual layers vary greatly from day to day and month to month with the rate of egg production and the differences in individual preferences and bodily needs. The free choice of whole grain and a suitable mash supplement permits layers to satisfy their individual differences and requirements."

Since an adequate supply of vitamin A seems necessary to prevent the occurrence of nutritional roup in fowls, a test was conducted in Arizona to determine whether alfalfa meal could be used in place of bran as the base for a suitable dry mash. Two rations consisting of ground sorghum seed, ground barley and cottonseed meal with bran as the base in one, and alfalfa meal in the other, were compared. It required less feed to produce a dozen eggs with bran as a base than with alfalfa meal.

There is general agreement that for continued egg production a high protein content in the ration is demanded, at least 17 or 18 per cent. How to compound such a ration is a problem for each poultryman to meet. It depends largely on the local availability and cost of the nu-



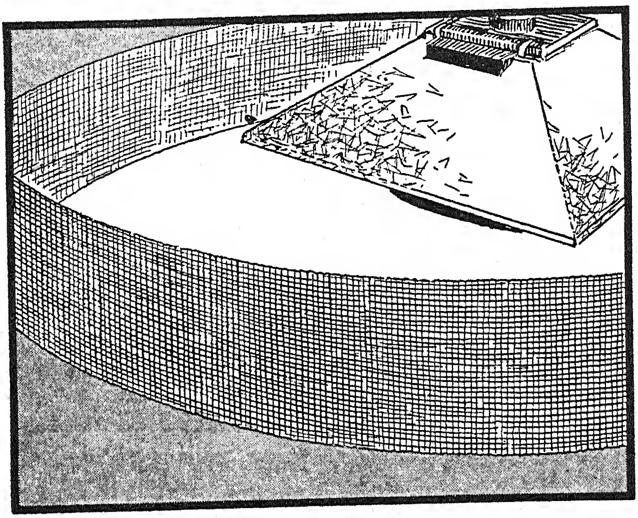
MARKING PUREBRED FOWLS

10 X 10 CONNECTICUT TYPE OF SHELTER

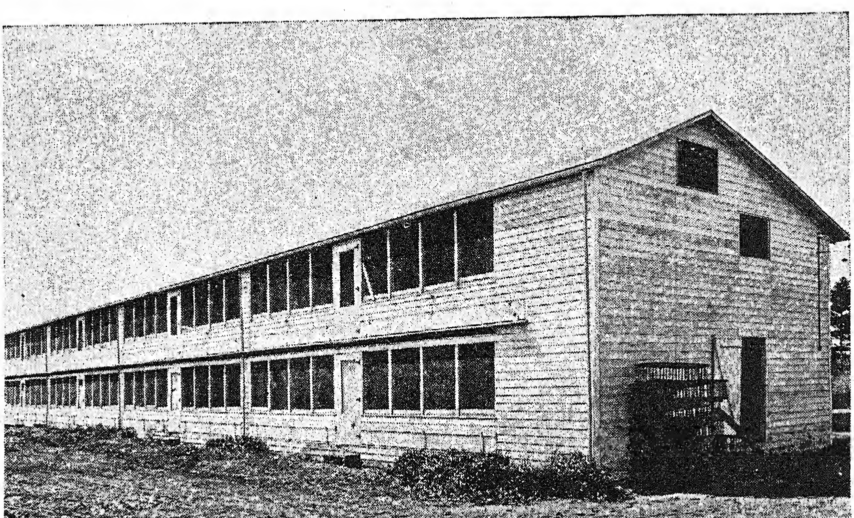
merous highly nitrogenous feed stuffs. In Arizona a comparison of meat scraps, cottonseed meal and dried buttermilk put buttermilk first, meat scraps second and cottonseed meal third in efficiency. But the mortality was least in the group that received cottonseed meal, thus showing that this feed is not toxic when fed in proper proportion.

All experiments show that it is a mistaken notion of economy to feed either growing young chickens or laying pullets a "wide ration" containing too little protein. The rapid and full development of bone, muscle, vital organs, blood and feathers, as well as eggs, calls for protein. The birds themselves evince their instinctive feeling for the need of protein by eating narrow nitrogenous rations with more relish. Grains contain some protein but animal protein seem to be necessary for best results. It is commonly recommended that 25 to 40 per cent of the protein of the ration be of animal origin. Beef meal, fresh meat scraps, buttermilk, dried blood and fish products are satisfactory.

Various deficiency diseases are asso-



THE HARDWARE CLOTH GUARD FOR BROODER CHICKS



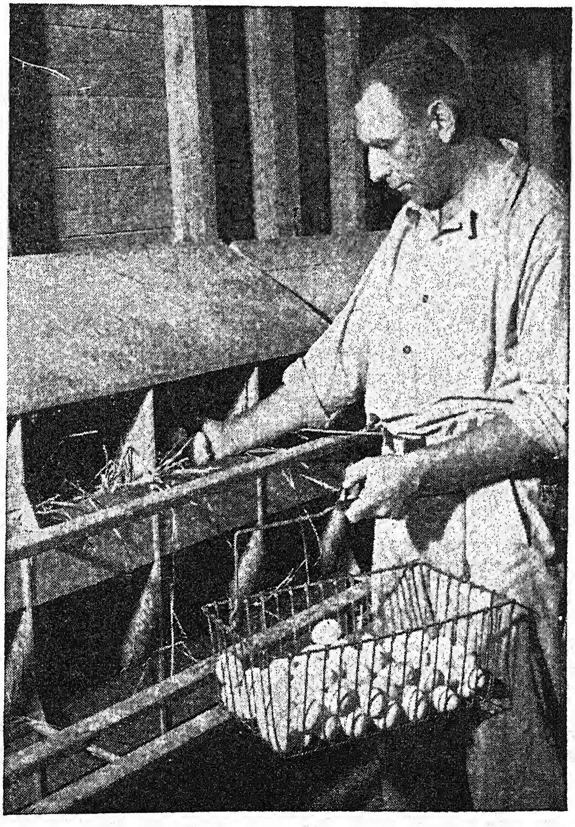
COMMERCIAL POULTRY LAYING HOUSE

ciated with improper or inadequate diets. Toe paralysis, dermatosis, slipped tendon, feather picking and cannibalism may be mentioned as examples of such troubles. The two last named habits may usually be cured by adding 2 to 4 per cent of salt to the diet. Salt is the best source of chlorine which is one of the essential mineral elements of a fowl's diet. Lime is another, and it may be supplied in the form of oystershells or limestone. Steamed bone meal will furnish the needful phosphorus, and manganous sulphate will add the requisite manganese to the ration. The dozen or more other inorganic elements necessary for normal nutrition need cause no concern since ordinarily they will be adequately supplied in a properly varied ration. Among the many formulas for mixing a vitamin-portein concentrate H. W. Titus suggests the following one which may be mixed with suitable ground grain.

Chicks are ready to eat as soon as they

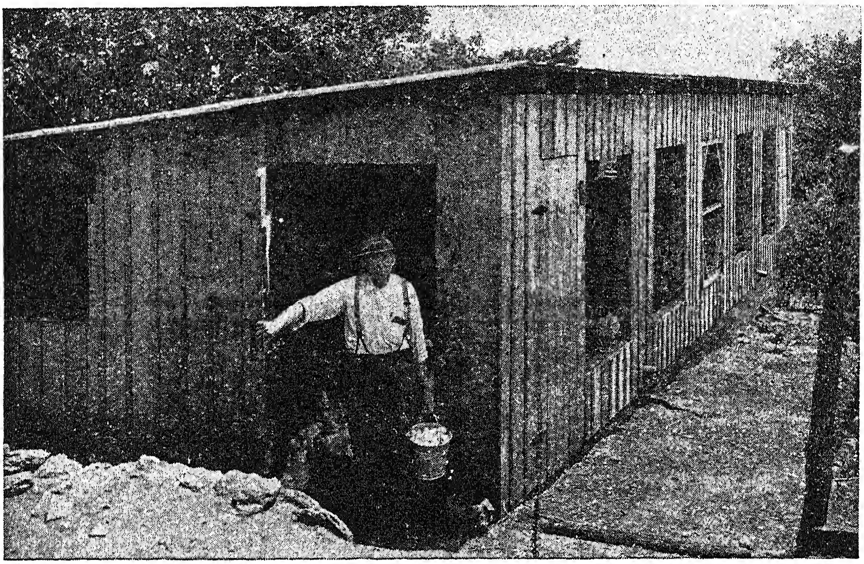
Mixed Protein-Vitamin Concentrate

Ingredient	Parts by weight
Alfalfa-leaf meal	25
Dried skimmilk or dried buttermilk	20
Fish meal or meat scraps, or both in any proportion	20
Soybean meal	10
Corn-gluten meal	5
Linseed meal, old process	5
Steamed bone meal	10
Ground limestone	1
Salt mixture	2
Cod-liver oil	2
	100



GATHERING THE EGGS

are dry and strong enough to walk, or about 24 to 30 hours after hatching. A good dry mash to start feeding them, as recommended by the Oklahoma Station, contains a mixture of 25 pounds each of bran, shorts and yellow corn meal, 8 pounds of alfalfa meal, 6 pounds meat and bone scraps, 5 pounds each of dried buttermilk and cottonseed meal, and 1 pound salt. Finely cut green leaves may be added after the first feed and should be continued from then on. Grain is added to the diet at the age of 4 to 6 weeks.



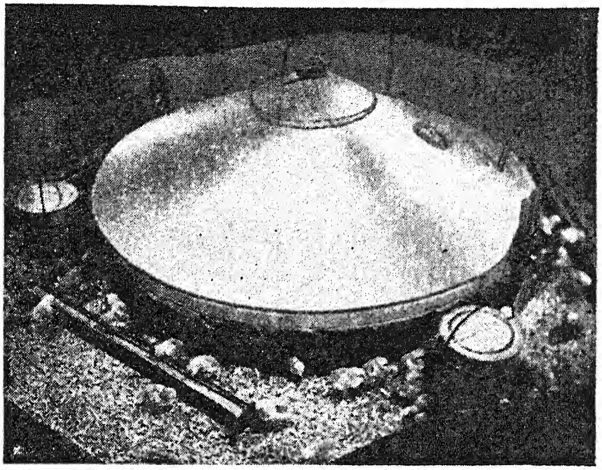
GATHERING THE EGGS

In the brooder each chick should have about 8 square inches of floor space under the hover and 48 square inches outside the hover. About half the floor space of the brooder should be covered with clean gritty sand and the other half with clean dust-free litter of chopped alfalfa or straw or other material. "The temperature should be 90° to 95° at the edge of the hover, perhaps 100° to 105° farther under the hover and about 70° outside the hover on the floor of the brooder. These temperatures should be maintained at least for the first week." It seems unnecessary in this connection to discuss methods of procedure with incubators since the manufacturers furnish detailed directions to each buyer.

Caponizing surplus cockerels has not proved to be a profitable side line of the poultry industry on the general farm. A survey of 250 farms in Kansas disclosed the fact that "few farmers, if any, produce large numbers of capons consistently over a period of years. Amateurs for the most part attempt to produce capons for a year or two, then give it up, probably because of the large number of slips and failure to attain the enormous size reported in advertisements. Good profits can be made raising capons by those who understand the business and follow it consistently as a major enterprise."

Other tendencies were brought to light by a study of these 250 farms by surveys made 14 years apart. There was a reduction of 32 per cent in the number of birds per farm during a period of low egg prices and high prices for feed. The egg yield per hen is increasing. Less home hatching and more buying of chicks from commercial hatcheries is the rule. More attention is given to providing vitamins and protein in the ration by using more meat scrap, fish meal, soybean meal, milk and green feed.

In Feeding for Market less attention is required to securing exercise, since the period of feeding is usually not long and fowls are killed when ready for market. At the West Virginia Station a narrow ration was found to be more profitable than a wide ration for growing chickens. Corn fed exclusively did not give satisfactory results at the Cornell Station, especially in the development of feathers. When an abundance of milk is fed, green food may



OIL BURNER MAY REPLACE ELECTRIC BULB IN THIS BROODER

be omitted for short periods. Experiments have shown that with young chickens differing only 6 weeks in age a gain in weight is more rapid and economical in younger than in older broods. In general, the cost of gain increases with age, and also with the increase in weight. In Ontario the following amounts of grain were required per pound of gain: first week 1.8 pounds, second week 4.8 pounds and third week 5.5 pounds. At the Canadian Stations and in Maine better gains were obtained when chickens were given some liberty than in those which were too closely confined. At the Ottawa Station, Gilbert found that birds in pens with runs made larger gains on less food than fowls in fattening coops. The color of the meat, according to different experiments at the Ontario College, may be somewhat influenced by the kind of feed. A ration of ground oats and buckwheat moistened with skimmilk produced a creamy white meat, while a ration of yellow corn produced a deep yellow meat. Skimmilk also produced a white skin.

Sunlamps for Poultry. Sunshine has long been known to be of significance in promoting the metabolism and assimilation of lime and phosphorus. This is an important matter in the case of laying hens, since egg shells consist largely of calcium carbonate. To produce 24 two ounce eggs per month the hen must assimilate and deposit in the egg shell about 5 ounces of mineral. In a comparison of fish oil in the ration with the use of a sunlamp for 2 hours, 5 to 7 A.M., daily the Nebraska Station found that fowls which received sunlamp rays during 121 days laid more eggs of

SHIPPING CASE FOR CHICKS

greater weight and of higher hatchability than those that were fed fish oil as a source of vitamin D. In summer natural sunlight seems to be quite adequate, but from October 15 to March 15 it is far less effective. Similarly in Ohio daily exposure for 1 hour to sunlamps proved an "effective and economical means of providing the vitamin D factor for growth of pullets, egg production and fertility."

Diseases:

INFECTIOUS CORYZA or ROUP is a contagious disease which affects the mucous lining of the mouth, larynx, nose and eyes. The infection often extends into the lungs and intestines. The disease is to be recognized by a yellow, thick mass of false membrane on the mucous lining of diseased parts. The false membrane is attached to the underlying tissues so that a bleeding surface is left when it is removed. The eyes are often covered over by such membranes and when the larynx is attacked the opening may be closed, so that the chickens die of strangulation. The first symptoms are a thin, watery discharge from the eyes and nose, and general debility. A slight rise in temperature is noted and after 3 or 4 days the false membranes become conspicuous in the mouth. The disease is contagious and may be transmitted by healthy fowls eating pieces of the membrane which have been thrown upon the ground by diseased fowls. The disease closely resembles diphtheria of man and is caused by a bacillus which is similar to that of fowl cholera. Roup may also be transmitted by the virus coming in contact with the eyes of healthy fowls.

In treating the disease it is important that all affected fowls should be at once separated from the healthy fowls and should be placed in comfortable quarters with plenty of feed. The false membranes may be scraped from the throat and nostrils and the raw surfaces treated with carbolic acid, 1 part in 200 parts of water, peroxid of hydrogen in a 3 per cent solution with water, boric acid or with a solution of nitrate of silver in the proportion of 8 grains to 1 ounce of water. The surfaces from which the false membranes are removed may also be rubbed with a stick of lunar caustic and the mouth cavity may be washed out with a nitrate of silver solution, as just mentioned.

BOXING YOUNG CHICKS FOR SHIPMENT

FOWL CHOLERA is a contagious disease due to the action of a specific bacillus. Diseased birds become rapidly emaciated and exhibit a constant and profuse diarrhea. Medical treatment of the disease is not successful. Fowl cholera may be prevented from spreading through the whole flock by proper hygienic precautions. All chickens dead of the disease should be buried or burned at once, and all affected birds should be removed to some distance

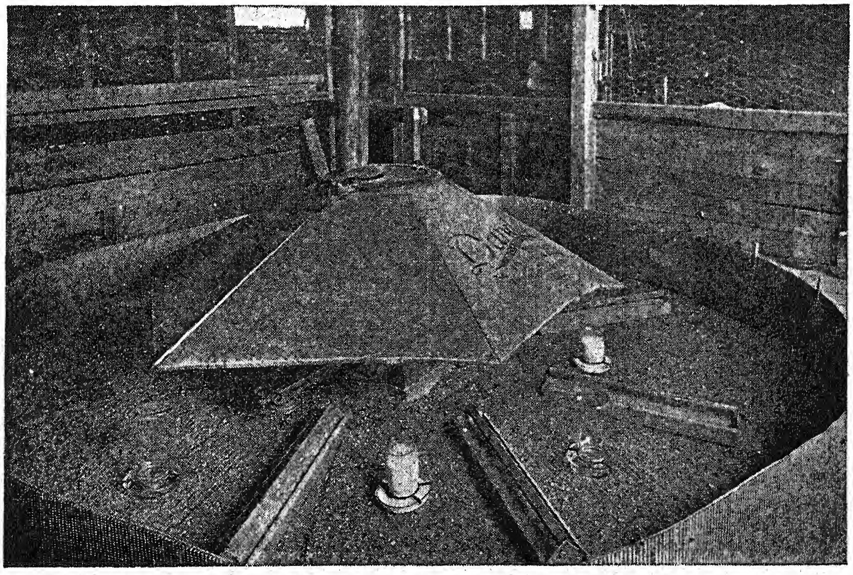
PLACING STRAW IN NEST

from healthy fowls. After an outbreak of the disease the poultry house must be thoroughly treated with a disinfectant, such as a 2 per cent solution of chloride of lime.

TUBERCULOSIS in poultry is a chronic disease usually affecting the liver and intestines, and the pathogenic bacteria are therefore scattered in the yards by the feces, and may be carried on the feet of wild birds or of visiting persons. Loss of weight, paleness of comb, and sleepiness are prominent symptoms. There is no cure. All diseased birds should be destroyed and the premises thoroughly disinfected.

FOWLPOX, also called diphtheria, is due to a virus which attacks the chicken usually on some part of the head. The first symptom is the appearance of a small eruption near the eye, ear or on the bill. Later other eruptions appear and spread until the eyes are covered and the fowls unable to find their feed. As soon as a diseased chicken is noticed it should be removed and the premises be disinfected.

In order to diminish the possible interference with the productivity of the flock, the birds should be vaccinated at 3 to 5 months of age. Vaccination of a flock of poultry is not recommended, however, under any circumstances unless the disease has been known to exist on the premises, or the owner considers that his flock is in danger from infection in neighboring flocks. Neither should chickens be sub-

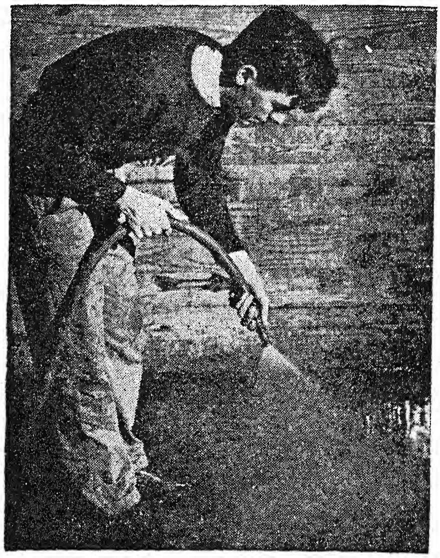


MODERN BROODER HOUSE

jected to the ordeal of vaccination when in a debilitated, sickly condition, or when heavily infested with parasites. Show birds or those in egg-laying contests should be immunized against fowlpox at least 6 weeks before being sent to exhibitions or contests.

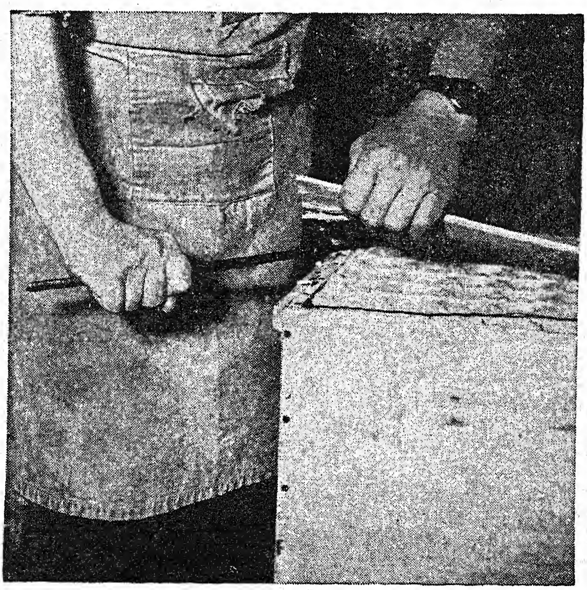
There are 2 methods of vaccination, the stab, or stick, method and the follicle method. The stab method is a more recent development and seems to have several advantages over the older follicle method; vaccination can be accomplished much more easily and quickly, much less vaccine required, and it is more sanitary.

In the stab method a narrow, sharp-pointed knife or lancet with adhesive tape wrapped around the blade about ⅛ inch from the point is used. Vaccination is accomplished by dipping this instrument into a bottle of vaccine and making a quick stab sufficient to penetrate the skin. The most convenient site to vaccinate by this method is on the outside of the leg near the "knee" (patellar) joint where the rows of feathers are far apart and the stab can easily be made between the rows.



SPRAYING FLOORS AND WALLS

GAPES is due to a threadworm (*Syngamus trachealis*) in the windpipe. Poultry attacked with this disease have fits of coughing, walk and stand in a drooping posture, and lose weight rapidly. It is believed by many authors that the gapeworms live during one of their stages in earthworms, and that, therefore, poultry may become infested by eating earthworms. Some experiments conducted for the purpose of obtaining evidence on this point indicated quite clearly a connection between the disease and eating earthworms. Chickens allowed to run upon the ground and eat earthworms ultimately became affected with gapes, while no case of gapes developed in those which were



LIFTING LID OF EGG CASE

SCRUBBING FLOORS

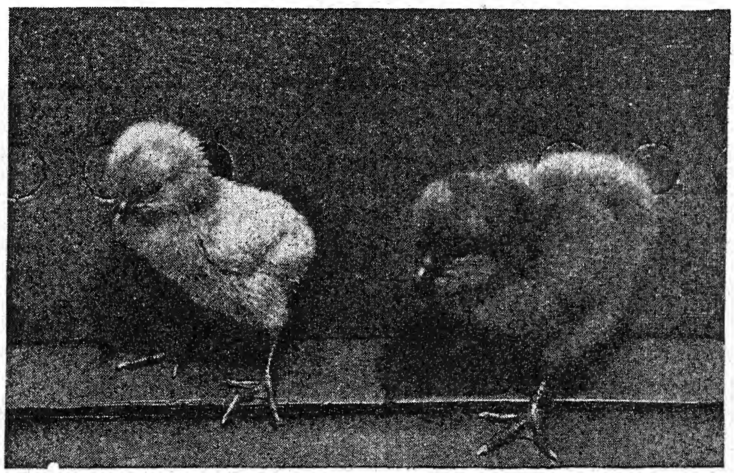
kept on a plank floor or in wooden cages with wire gauze sides. Experiments in feeding chickens earthworms produced evidence that the gapes may be acquired in this way. On the basis of this belief, it has been recommended that when chickens are allowed to run outdoors the soil should be previously saturated with a strong solution of salt for the purpose of destroying the earthworms. For the removal of the gapeworms in the windpipe several remedies are effective. Turpentine may be applied inside by means of a feather. The fowls may be closed in boxes and made to breathe the dust of barium antimonyl tartrate for 15 minutes.

Pullorum Disease. As observed by Dr. Hubert Bunyea, of the U.S. Bureau of Animal Industry:

"Pullorum disease (bacillary white diarrhea) is quite widespread existing in every section of the United States where appreciable numbers of poultry are kept. It causes heavy financial losses, resulting from the deaths of baby chicks, diminished egg production in hens and pullets, reduced hatchability of eggs, and occasionally the deaths of hens due to generalized pullorum infection. Pullorum disease at times causes severe losses among turkey poults which were incubated or brooded in contact with pullorum-diseased chicks. This danger is largely overcome by incubating turkey eggs separately and rearing the poults apart from chicks. Fortunately pullorum disease does not attack other species of domestic fowls to any serious extent.

"*Cause.* The disease is caused by a toxin-forming germ which is known as *Salmonella pullorum.* Although this germ is quite easily destroyed by direct sunlight, heat, or disinfectants, it has been known to remain alive in soil or manure in sheltered places for many days, or even months. The primary seat of pullorum infection is the ovary of the infected hen.

"*Mode of dissemination.* The disease is commonly transmitted from the hen to the chick by means of the egg. All eggs laid by an infected or 'carrier' hen do not contain the organism *Salmonella pullorum,* but infected eggs, if hatched, pro-

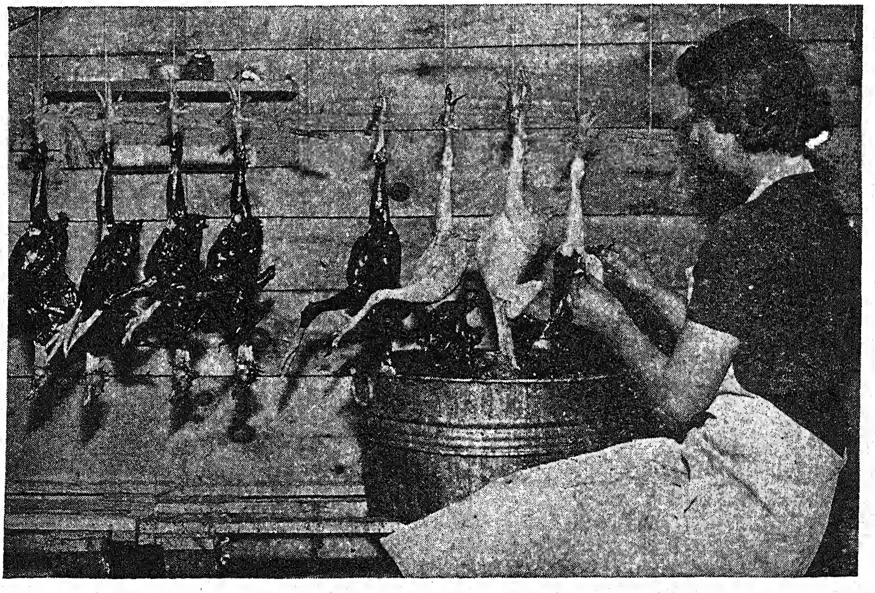


GOOD (RIGHT) AND POOR (LEFT) BABY CHICKS

duce infected chicks. Such chicks may die of the disease any time during the first 3 weeks of their lives, or they may survive to maturity and repeat the cycle by themselves producing eggs and chicks infected with the organism. Chicks having the disease are constantly voiding enormous number of the germs in their droppings, thereby spreading the infection. The hatching of infected eggs in an incubator or under a hen may result in the transmission of the disease to other chicks hatched from uninfected eggs in the same incubator or brood. Infected chicks placed in a brooder house with healthy chicks will spread the disease. In the case of the hatchery chicks, however, the danger of acquiring the disease is multiplied by the fact that the eggs for hatching are frequently assembled from a number of flocks, and if one or more of these flocks happen to be harboring the infection, the entire output of the incubator is exposed to the menace of the disease. Many progressive hatcherymen have already realized the importance of taking the initiative in protecting their customers from pullorum disease by requiring the flocks which supply them with eggs to be tested for the presence of pullorum-disease carriers and by using proper hygienic measures in their hatcheries."

WING BANDING THE CHICK

COCCIDIOSIS is an infectious disease common in both domestic and wild birds and caused by protozoan organisms of which 6 or 7 species are concerned. In Oregon it is reported to be the most widely spread parasitic disease of fowls. The organisms are spread by the feces of infected fowls. Cecal coccidiosis is usually characterized by bloody diarrhea and is most frequent in young pullets. No direct remedy is of avail. As soon as an outbreak of the disease appears the daily removal of litter and droppings should begin and should continue for 5 to 7 days. The droppings



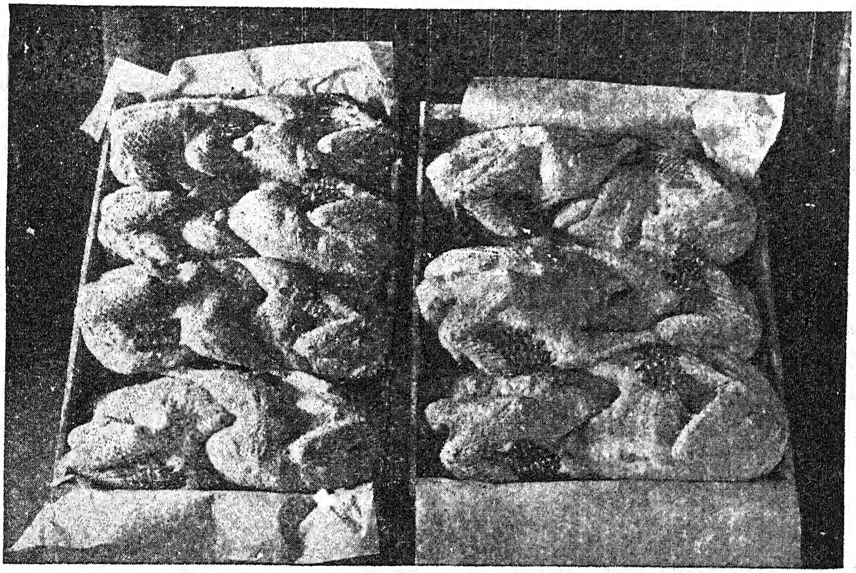
DRESSING POULTRY

should be removed not only from the floor but also from the perches, crossbars and other flat surfaces. As disinfectants cresol or other coal-tar creosotes in strong hot solutions may help materially. If all infected birds are confined and the droppings thus disposed of for several days the outbreak may be checked. This disease is widely distributed throughout the country.

Fowls are subject to various kinds of intestinal worms. Carbon tetrachloride and tetrachlorethylene have attracted attention as efficient in the expulsion of these parasites. Fortunately chickens and turkeys are tolerant of carbon tetrachloride in 1 to 3 cc. doses in capsules.

Internal Chicken Mite (*Cytodites nudus*) is white in color and barely visible to the naked eye. The mite is found in the lungs, air sacs, windpipe and in the body cavity of the common fowl and other domestic birds. It occurs in a number of widely separated localities, and may be considered of rather frequent occurrence. According to some authors the presence of the mites may cause a cough and strangulation of the birds, accompanied in some instances with diarrhea. The mites have been found, however, in healthy fowls, and it must therefore remain doubtful whether the mites are the cause of serious disease. The mites probably gain entrance to the body in the food.

Scaly Legs is caused by a mite known as *Cnemidocoptes mutans*, which burrows underneath the skin of the legs and sets up an irritation which leads to an exudation of fluid, which becomes gummy on drying. The mites remain under these crusts. Affected birds should be removed from the rest of the flock, and the roosts and woodwork of their quarters should be treated with boiling water or whitewash to which a little carbolic acid has been added. The scales should be removed and exposed surfaces treated with crude petroleum.



DRESSED PLYMOUTH ROCKS

Another form of the disease known as depluming scabies attacks the feathers, causing them to break off near the skin. The disease begins at the rump and spreads from there to all parts of the body. It is due to a mite closely related to that which causes scaly legs. Affected birds should be isolated, and the diseased areas may be rubbed with the carbolized ointment recommended for scaly legs.

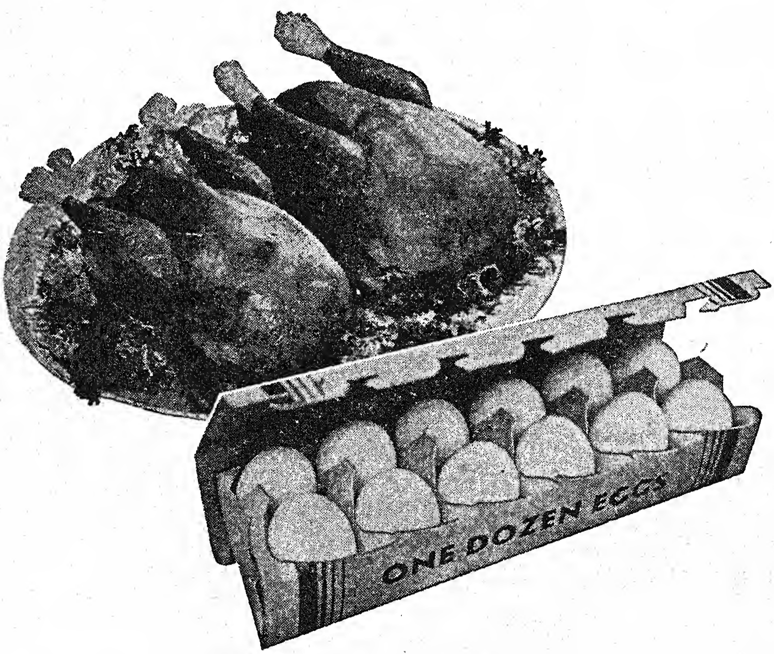
Favus, also known as white-comb or baldness, is due to the same fungus which causes one form of ringworm in mammals. The disease appears first upon the comb and neck as yellowish-gray areas of circular or irregular outline. As the disease progresses the skin becomes covered

with a crust sometimes 1/4 of an inch in thickness. The feathers fall off from affected areas, leaving the skin bare. Favus is contagious and should be treated accordingly. Affected areas may be washed with warm water, so as to render the removal of the crust easy, and the parts may then be treated with tincture of iodine.

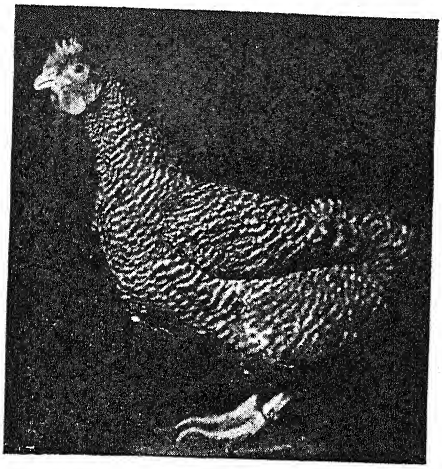
Lice Mites and Ticks. Chickens are attacked by a considerable number of parasitic insects and mites. Among the species which are most common on chickens, mention should be made of the chicken flea, chicken tick and various species of chicken lice. These pests when present in great numbers constitute a serious drain upon the energy of the birds and cause considerable irritation of the skin.

Disinfection. Henhouses which have become infested with lice, mites or ticks sometimes resist all attempts at disinfection, and if the structures are not especially valuable, it may be well to burn them and build a new structure on fresh uninfested ground. Where such method is not practicable, the walls may be sprayed with kerosene or treated with whitewash to which carbolic acid has been added in the proportion of 4 ounces to 1 gallon of whitewash, or if the houses are air-tight, they may be thoroughly fumigated with sulphur. As a general spray for infested poultry houses anthracene oil or paraffine oil emulsion are efficient. Black leaf 40 applied to the roosts in a thin layer just before roosting time is a good treatment for all kinds of lice except the head louse. The Florida Station report that

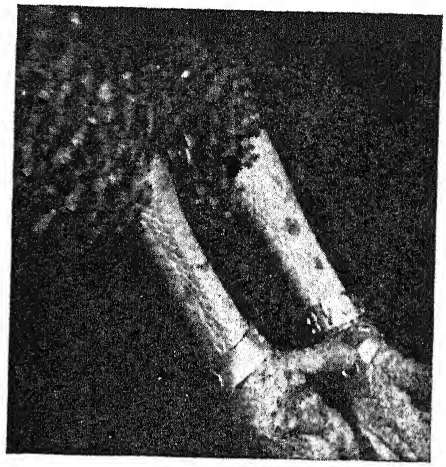
KNIFE BLADE BOUND WITH ADHESIVE TAPE TO 1/8 INCH OF TIP FOR VACCINATING AGAINST FOWLPOX



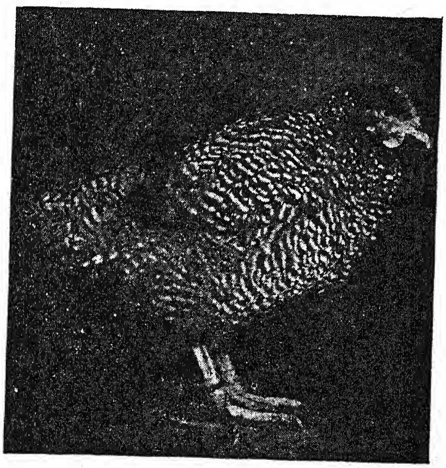
APPETIZING POULTRY PRODUCTS



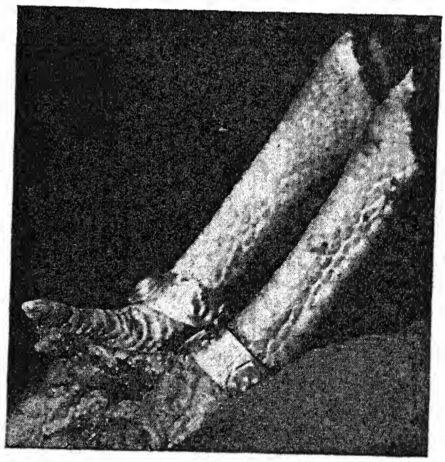
ALERT BIRD



SMOOTH SHANKS



MOPEY BIRD



ROUGH SHANKS

"Chicken lice (the large and small body louse, shaft louse and fluff louse) were completely eradicated from 10 farm flocks by feeding 5 per cent of dusting sulfur in the regular mash for a period of three weeks and scattering sulfur over the soil in the yards at the rate of 2 pounds per 100 square feet.

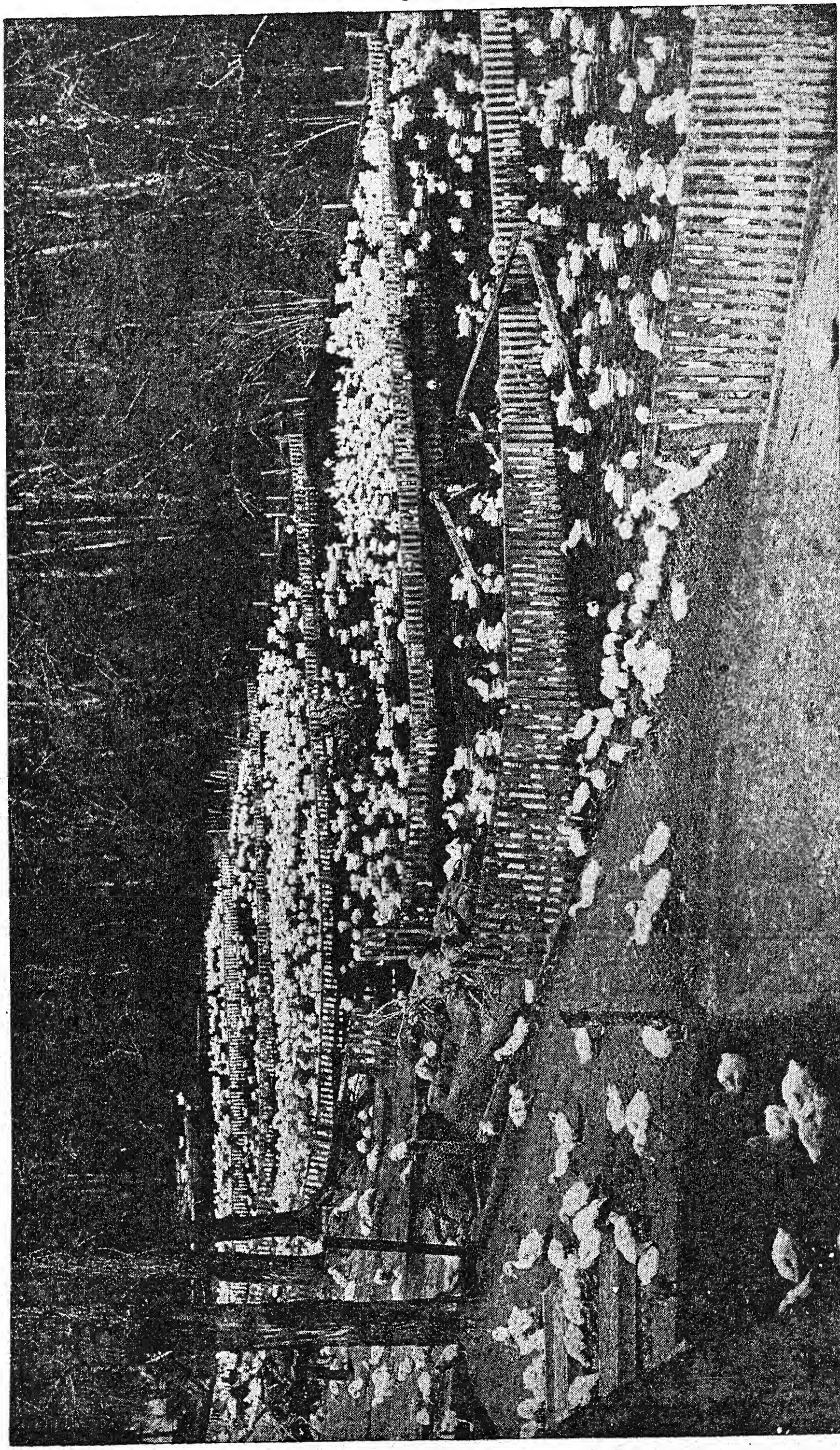
"Sticktight fleas were completely controlled by a similar procedure in eight farm flocks. Combined infestations of lice and fleas were controlled successfully on seven farms by the same procedure.

"Sulfur getting onto external parts of the birds appears to be the important factor in this means of control.

"The common chicken mite was controlled successfully on eight farms by dusting sulfur about the house and on the litter, dropping boards and nesting material."

DUCKS

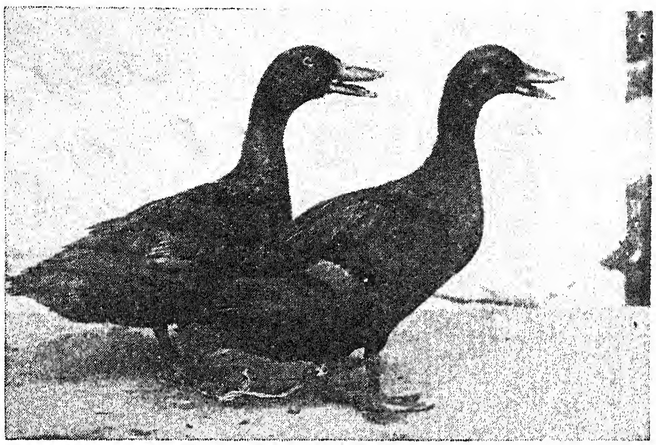
Ducks are raised primarily for meat production and only incidentally for eggs, which, however, are very palatable unless the ration contains too much fishy flavored feeds. As a rule the ducks that are raised on farms are too few in number to affect the price. Like chickens, ducks may be raised in large numbers in confinement. There are many special duck farms that turn out 4000 to 20,000 ducks annually. According to the latest census



PEKIN DUCKS IN CONTENTMENT

about 12 million ducks are raised annually from a stock which at the start of the breeding season numbers 2½ million as reported by the 260,000 farmers who grow ducks.

Among the 11 breeds of ducks recognized in the U.S. a few notes may be given on the most important ones. The meat class includes the Pekin, Aylesbury, Muscovy, Rouen, Cayuga, Buff and Swedish. The Indian Runner and its offshoot, the Khaki-Campbell, are the only egg-type breeds. The remaining breeds, such as Call, Crested White and Black East India, are ornamental. All these breeds, except the Muscovy, are derived by selective breeding from the wild Mallard, which itself has been domesticated. The Muscovy is of South American origin.



EAST INDIA DUCKS

PEKIN is practically the only breed by which the commercial growers set store, and is by all odds the most popular duck on general farms. They make rapid gains to a weight of 4½ to 6 pounds at the age of 9 to 13 weeks when they are sold as "green ducks." The chief centers of commercial duck farms are Long Island and certain localities in the vicinity of New York City, Philadelphia and Boston. These intensive duck-rearing enterprises are made possible for the reason that ducks are less subject to disease than chickens, endure confinement better and are more easily handled in brooders. The Pekin are of a creamy-white color, yellow skin and shanks, are hardy, non-broody and good layers.

The AYLESBURY in England occupies the same place as the Pekin with us, but is not so popular in this country. The color is white, the size about equal to the Pekin.

The ROUEN resembles the Pekin in size and form. The back of the drake is gray mixed with green, somewhat like the wild Mallard. It may exceed the Pekin in weight but does not make as rapid gains.

The CAYUGA is black, early maturing and suitable for production of green ducks, but on account of its color not so popular on the market as the Pekin.

The MUSCOVY occurs in white and dark varieties. Crosses with other ducks are usually sterile. The body is long and broad. Standard weight of the drake is 10 pounds and 7 pounds for the duck. Its wings may be clipped to prevent it from flying away. The call is not the noisy quack of other ducks but a sort of wheezy sound.

INDIAN RUNNER occurs in 3 color patterns, fawn, white and penciled. The birds are much smaller than the meat breeds, attaining a weight of only 4 pounds. The Runner and the Khaki-Campbell are hardy, good foragers, make broilers of 3 pounds weight at 6 weeks of age and lay up to 200 eggs a year. The eggs weigh 32 ounces to a dozen. In New Jersey the average egg yield of 2 flocks of Khaki-Campbell ducks was 200 for the first year and good production continues for 3 or 4 years. The total weight of the eggs produced by these ducks is considerably greater than that of the egg breeds of fowls.

None of the domestic ducks is really a good brooder. Often they make no pre-

tense of building a nest but lay their eggs, if unconfined, here and there, one in a place, on the ground, in water or wherever the idea occurs to them. On general farms duck eggs are commonly set under hens. Hens make good stepmothers for the ducklings, although sometimes showing displeasure at the aquatic habits of the ducklings. On special duck farms the most modern appliances for artificial incubation and brooding are in use. The period for incubation for duck eggs is 27 or 28 days, sometimes 30. On farms any of the meat breeds of fowls make good duck mothers.

For a long time it was a moot point among duck raisers whether success with ducks depends on their having access to ponds or running water. Prominent breeders such as J. Rankin stoutly maintain that ducks are not to be pampered by indulgence in aquatic sports, that water for bathing purposes is not at all essential for them, but that an abundance of fresh water for drinking must be provided. But recent opinion veers in the other direction. As stated by A. R. Lee "the most desirable site for a duck farm is on a light, sandy soil with a gentle southern slope, leading to a stream so that the pens for the breeding ducks may be extended 25 feet or more into running water. The fertility of the eggs is higher, as a rule, if the birds have access to water. A natural supply of water lessens the labor and is therefore almost essential to commercial duck farming."

Ducks differ from chickens in that they have no crops and their food goes directly into the stomach. On this account ducks require that a much larger proportion of their food be soft. In fact dry, hard grain should be reserved almost entirely for mature birds. In a feeding program, as outlined by the Department of Agriculture, "The principal part of all duck rations is fed as a wet mash, usually mixed in dough mixers or in good-sized mixing machines. For breeding ducks a light feed of whole corn is ordinarily used with the mashes. All duck rations are mixed with green feed or with cooked vegetables substituted for the green feed. Green feed consists of creek grasses, alfalfa, clover, young corn, rye, cowpeas, or any other available green feed, cut up—usually with a machine—in lengths of about one half inch. Rye is one of the first green feeds available in the spring and is followed by alfalfa and oats and then by fodder corn. Rape may be sown in August for late feeding and is usually available until freezing weather. Alfalfa-leaf meal may be used in the mash, and if no green feed is available, cooked vegetables may be used at the rate of one fifth of the mash. Commercial duck feeds are quite commonly used for starting the growth of the ducklings and are also used for older ducks by many growers.

"Ducklings are usually fed as soon as they are put in the brooder houses. For the first 5 days they should have a moist mash consisting of 35 per cent yellow cornmeal, 31 per cent bran, 10 per cent flour or middlings, 5 per cent alfalfa-leaf meal, 5 per cent dried milk, 5 per cent meat scrap, 5 per cent rolled oats, 3 per cent sand, and 1 per cent salt. One per cent of cod-liver oil should be mixed with this mash, the oil being mixed with not more than 2 weeks' supply of the feed at one time.

"Infertile incubator eggs may be used in place of the milk in this ration at the rate of two eggs, boiled hard and crumbled, to each quart of feed.

"The ducklings are usually fed all they will clean up, four times daily, until they are 2 or 3 weeks old, and then three times daily until they are marketed. Sand or grit should be kept before them at all times. When they are 2 to 3 weeks old the mash may be replaced by one consisting of 45 per cent cornmeal, 24 per cent bran, 10 per cent flour, 10 per cent meatmeal, 5 per cent ground oat groats, 3 per cent ground limestone, 2 per cent dried milk, and 1 per cent salt. Green feed to the amount of 10 per cent of the mash, by bulk, should be added to the ration when the ducklings are at this age, and the cod-liver oil omitted. When the ducklings are about 6 weeks old, or when they are well feathered, they should have a fattening ration of 50 per cent cornmeal, 18 per cent bran, 13 per cent flour, 12 per cent meatmeal, 5 per cent ground oats, and 2 per cent dried milk, with 10 per cent of the bulk of the mash, in green feed, added."

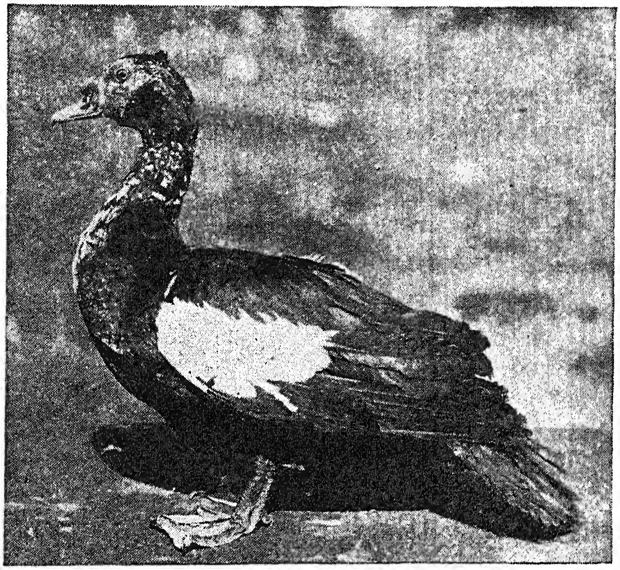
The very great value of animal feed for ducks was strongly brought out in experiments reported by the New York State Station. At that Station a ration was fed in which ½ the protein contained was derived from animal meal. This was compared with a ration containing the same amount of protein but derived wholly from vegetable sources. At 7 weeks of age the ducklings fed the animal meal ration weighed 3 pounds each and on the contrasted ration 1 pound each. At 9 weeks of age the ducks on the animal

meal ration weighed 4.5 pounds each and on the contrasted ration 1½ pounds each. At 11 weeks of age the weights were 5 pounds each on the animal meal ration and but 2 pounds each on the other ration. In this experiment the average weight of 3 pounds each was reached 8 weeks sooner by the ducklings fed the animal meal ration than on the contrasted ration.

In another experiment at the same station ducklings fed a ration made up wholly from vegetable sources failed to thrive and nearly ½ the flock died before they were 4 weeks old and the gains were very small. Similar ducklings getting meat meal in the ration all lived and thrived. When bone ash was added to the ration of vegetable origin so that the mineral constituents were equal in quantity to that contained in the animal ration, the gains were better than on a grain ration alone, but were still inferior to the gains made on the meat meal ration. From these and other experiments at the station, in which 170 ducklings have been experimented upon, it would seem that animal matter either in the form of meat meal or ground bone, fresh meat, or some other form, is absolutely essential to the healthy and rapid growth of ducklings.

On general farms duck yards and duck pastures should be occasionally plowed up and planted to forage or other crops. The progressive befouling of yards, and the development of disease will thus in large measure be avoided. For the most part the Long Island duck farms have sandy yards with slight slopes leading to an inlet from the sea. They are therefore cleaned by the rise and fall of the tide. All parts of the yard above tide water must be otherwise cleaned, by scraping off the top surface if necessary. Ducklings are permitted access to water from the age of 6 or 7 weeks, and in that way keep the feathers clean.

The consumer demand for duck eggs and duck meat is limited and rather seasonal. Though duck eggs weigh one-fourth more than hens' eggs they fetch no more on the market except in the Easter season for only a few weeks. Market prices for duck eggs are best from December to April. Ducks may be raised with profit on general farms either for meat or eggs but best results should not be expected from allowing them to range at will without attention to their care and feeding.



MUSCOVY DRAKE

While ducks are far less subject to disease than chickens, they are sometimes afflicted with cholera and other troubles which are discussed under Chickens.

GEESE

Geese may be raised in all parts of the U.S. but the center of production is in the Middle West, particularly in Iowa,

Minnesota, Illinois, Wisconsin, Missouri and other neighboring States. According to the 1940 Census something over a million geese are raised annually. Only about one farmer in ten keeps geese and there are no special goose farms of commercial size. This is due to the monogamous nature of geese. The Canada goose is strictly monogamous and so are some ganders of other breeds. At most ganders will mate with only 4 or 5 geese, and pair or trio matings are better. This trait entails the

AFRICAN GANDER

maintenance of a number of expensive ganders if the industry is to be conducted on a large scale. Moreover their feeding habits militate against success with large flocks. Geese are primarily grazing birds. Good pasture and water are their chief needs. They are as able to live exclusively on pasturage as are sheep. Geese graze so closely that they may even kill the grass unless a system of pasture rotation is adopted.

It is practically impossible to raise goslings without grass or other vegetable food such as clover, roots or cabbage. Geese, like ducks, have no crop and require soft food and at frequent intervals. Geese do not become mature until the second or third year. Good results from breeding are not to be expected from younger birds. In fact the eggs of younger geese may not be fertile. Under favorable conditions they live on to an extremely old age, 50 to 75 years or older. Some geese continue to lay and may be kept for breeding purposes till 25 years old, but ganders should not be kept past the age of 7 or 8. Both sexes are feathered almost exactly alike, but the ganders have longer necks and higher pitched voices than the geese. Geese are raised mainly for their flesh and feathers. Most of us can perhaps recall featherbeds and feather pillows, and perhaps have seen the operation of plucking the feathers from the unwilling birds. Among the foreign-born in cities goose-fat is often substituted for butter. Goose flesh never brings as high price as fowls.

The European "old gray goose" of Mother Hubbard tales, is the ancestor of all six breeds of geese now raised in the U.S.

The Toulouse is perhaps the heaviest breed, the gander reaching 25 pounds. It matures slowly and requires a thorough fattening in order to look well on the market, and is characterized by an abdominal pouch. Toulouse geese usually lay more eggs than the Embden or African, but fewer than the China variety. They are gray with a square body.

The Embden resembles the Toulouse in shape but is pure white. The body is carried a little higher from the ground. This breed lays earlier than the Toulouse and the eggs are larger.

The African is dark gray in color with a brown stripe down the back of the neck. The head bears a knob at the base of the bill and a dewlap under the throat.

The China breed (brown and white) are smaller, weighing about 16 pounds at maturity. They are early, prolific layers. The body is carried very erect. The laying season extends from January to June. They are perhaps the noisiest of all the kinds of geese.

The Canada wild goose is of a quite different species but has been widely domesticated. It must be kept in close confinement to prevent escape to natural wild existence again. This goose is often crossed with African, Embden and Toulouse breeds to produce a mongrel goose for the early market. This cross gains weight rapidly and has a delicious flavor. The hybrid is usually sterile. The Canada goose lays only 6 to 8 eggs per season and broods her own eggs.

Like ducks, which are useful in destroying dandelions in yards, geese are often kept in the South to destroy weeds and grass in cotton fields, and in some Northern States for weeding strawberry beds.

The breeds of domestic geese lay from 10 to 50 eggs per season. The period of incubation is 30 to 35 days, the larger the breed the longer the period. About the first of February is early enough to set the eggs either under hens, geese or in incubators. As a rule goslings should not be hatched before the appearance of green grass, since food of this kind is quite necessary to their rapid and healthful growth. If set under hens they may not be covered so successfully as under the mother goose and some delay in hatching may occur. There is considerable variation in the fertility of goose eggs but usually it is very high.

Goslings need no food for the first 36 to 40 hours after hatching. For the first 3 or 4 days they may be fed like young ducks, or stale bread soaked in milk with a little scalded cracked corn added and chopped grass. If they receive an abundant supply of green grass they may require no other feed after the first 2 or 3 weeks. For small farm flocks of mature geese a ration of moist mash consisting of ⅓ shorts and ⅔ yellow corn meal, is recommended. The Department of Agriculture describes "another method which produces a much better fattened goose but involves considerably more work is to stuff large geese with noodles three or four weeks. From 8 to 10 geese are confined to a pen about 8 by 12 feet, which is kept heavily bedded with fresh oat straw. The feeder sits on a box in one corner of the pen, holds the goose between his legs and stuffs it with noodles, usually beginning by feeding from 3 to 5 noodles three times daily and gradually increasing to 6 or 7 noodles five times daily at four-hour intervals. The noodles are made of scalded corn meal, ground oats, ground barley, and ground wheat or wheat flour, about equal parts of each being used. Add salt as for bread, thoroughly mix the feed, and put it through a sausage stuffer, cutting the product into pieces 2½ or 3 inches long. Boil them from 10 to 15 minutes, or until they float, in a wash boiler containing a wire rack which stands 1½ inches above the bottom of the boiler. Dip the noodles in cold water and roll in flour to keep them from sticking together. Pour hot water over the noodles just before they are fed to make them slippery and keep them warm. The number of noodles fed depends on the size and condition of the bird and the judgment of the feeder. The noodles are put into the mouth, one at a time, and worked down by using the hands on the outside of the neck. At the next feeding time, if any feed can be felt in the crop, no noodles are given; otherwise the bird will go off its feed. Keep plenty of drinking water before the geese."

For so-called green geese the most active demand is at Thanksgiving and Christmas. If properly forced, ten-weeks old goslings of the large breeds should have attained a weight of 10 pounds.

Diseases. Geese are little subject to disease. Occasional outbreaks of cholera appear in a form resembling that in fowls. For a discussion of this or other goose diseases, *see* under *Chickens*.

GUINEA FOWLS

Guinea fowls, commonly known as keets from their persistent call, are but little grown commercially, but small flocks of 2 to 7 or 8 birds are to be found on farms, pretty generally scattered over the country but especially in Missouri, Oklahoma, Texas, North Carolina, South Carolina, Tennessee, Mississippi, etc. Over 125,000 farmers report raising them. Guineas are grown chiefly for their flesh for which there is a rather active demand in the hotels and restaurants of large cities on account of its gamy flavor. They are exasperatingly noisy birds but this noise may be turned to good account on farms where chickens and turkeys are allowed to range at will. At the sight of hawks or other enemies the guinea sets up such a clamor that other poultry, as well as the farm family, are warned and the enemies frightened away.

Domesticated guineas appear in three varietal colors, pearl, white and lavender. The Pearl Guinea is best known for its dotted purplish-gray plumage. The hen may lay 20 to 50 eggs before becoming broody. The eggs weigh about 1¼ ounces each, are of a spotted cream color, and more sharply pointed at the small end than are hen's eggs. The incubation period is about 26 days. Guineas are usually monogamous but may mate in the proportion of 1 male to 2 to 8 females. Their food may well be the same as for turkeys. The crop is small and when young the birds require feeding more often than chickens. Mature guineas are wide rangers and may be depended upon to pick up most of their ration in the form of weeds, grass, seeds and insects. At the age of 6 to 8 weeks guineas fly into trees to roost in response to their wild instinct, and unless induced to come

into poultry houses along with the hens, may become very hard to catch.

Late summer and fall is the regular marketing season for guinea fowls. At that time young birds weighing about 2 pounds are in greatest demand. Old birds are pretty dry and tough eating.

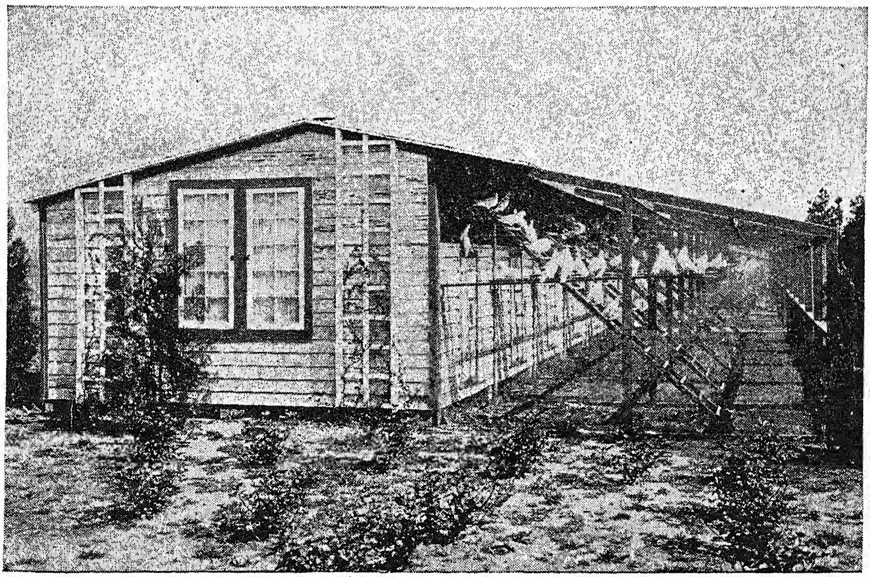
PIGEONS

The almost innumerable breeds of domesticated pigeons have all descended from the Blue Rock pigeons (*Columba livia*) of Europe. Experiments in crossing and in the production of varieties have been in active progress ever since the days of Darwin by naturalists and bird fanciers. Pigeons have, therefore, served the purpose of furnishing the basis for many scientific discoveries regarding the effects of crossing, inbreeding, variation and transmission of acquired characters. The number of breeds is in excess of that of all other domesticated birds. Many are bred for peculiar habits, or special ornaments on the head, beak, neck or legs, or for peculiar plumage or fleshy growths. This article is confined, however, to the farm or economic side of pigeon raising and cannot be concerned with the numerous breeds from the standpoint of a fancier.

Squabs have been defined as "young pigeons which are marketed before they are ready to leave the nest, usually at from 25 to 28 days of age, when they weigh from 12 to 24 ounches each." According to the Bureau of Animal Industry, the King, Carneau, Mondaine and Giant Homer are the preferred breeds for squab production. Several other breeds and crossbred birds are less extensively used in raising squabs.

Pigeons lay 2 eggs for each setting. Each female may lay 2 more eggs before the young pigeons of the first laying are fully feathered. The incubation period is 16 to 18 days and incubation is generally done by both parents, the male alternating with the female in covering the eggs. Pigeons are monogamous, a male mating with one female. When the breeding stock is carefully selected for prolificacy each pair should produce 12 squabs a year in 6 settings.

As observed by A. R. Lee, "The hen pigeon usually lays one egg, skips a day, and then lays again. If more than two eggs are laid it is advisable to remove the extra ones, as a pair of pigeons can raise only two good squabs at one time. The second egg usually hatches a day after the first. The smaller squab in the nest is likely to be the female, so when saving for breeders do not save only the larger squabs from the nest as this will give a much larger percentage of males among the young breeders. Both parents build the nest and take turns sitting on the eggs and feeding the young until they are marketed or until they are able to take care



PIGEON HOUSE IN FLORIDA

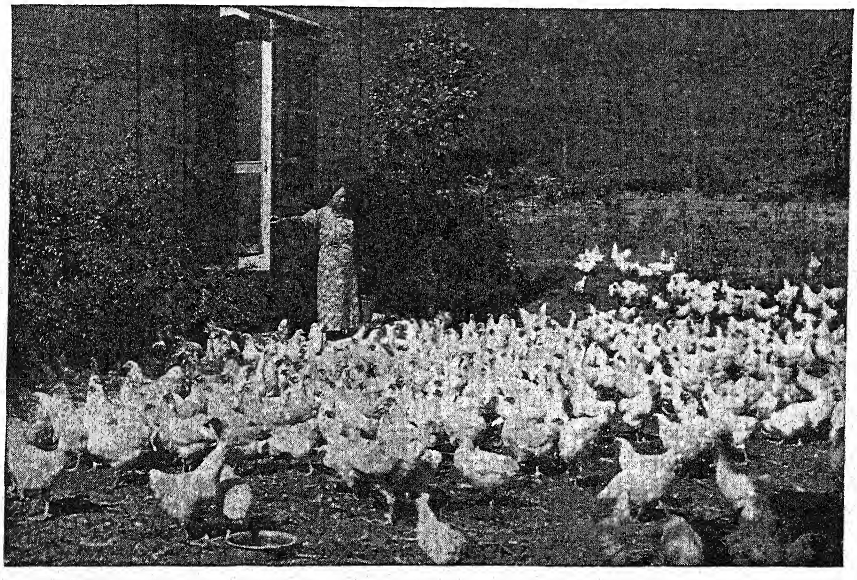
of themselves. The hen often lays another setting of eggs when the squabs are from 2 to 3 weeks of age and leaves the feeding of the squabs from then on largely to the male. Double nests are provided for each pair to discourage the hen from laying again in the same nest with the squabs since she would be disturbed by them during the incubation period.

"Squabs are reared and fed by both of the parent birds on a thick, creamy mixture called pigeon milk, produced in the crops of the pigeons. Pigeons usually feed their squabs shortly after they themselves are fed and should not be disturbed at that time. Care should always be taken not to frighten pigeons, and squabs should not be disturbed any more than is necessary. In case a squab dies during the first week or 10 days, another single squab may be placed in the nest, provided the two are about the same size. This procedure gives the pigeons without squabs a chance to begin producing again sooner than they would otherwise. It requires from 24 to 30 days for a squab to reach market age, the time varying with the size of the breed."

A pigeon feed recommended by the Bureau of Animal Industry contains in parts per weight, 35 of whole yellow corn, 20 of Kafir and cowpeas, 15 of hard wheat, 5 of oat groats and hempseed. Squab raisers do not give pigeons green or mash feeds but insist on hard, dry whole grain feeds. It is urged that the ration should carry 15 to 20 per cent of protein. A recommended mineral mixture contains oyster shell, limestone, charcoal, ground bone, salt and Venetian Red.

The buildings and plant for pigeon raising will depend entirely upon the extent to which one wishes to engage in the business. The enterprise can be conducted on a small or relatively large scale. In any case sanitation is as important as with chickens. Squabs are more subject to fatal disease than are the mature birds. The buildings must be dry, sunshiny, well ventilated but free from bad drafts. Yards, floors and walls of buildings may be cleaned and disinfected as recommended for poultry houses. Twice a year a thorough house-cleaning should be done, all parts being sprayed with white wash or hot lye water. For lice in the nesting boxes spray with creosote oil, crude oil or kerosene emulsion.

Diseases. Pigeons are subject to a number of diseases most of which occur in chickens and other domesticated birds. Roup, fowl pox and canker are discussed under *chicken diseases.* The same reference applies also to lice, ticks, mites and intestinal worms as they occur in pigeons. Wing disease in pigeons is characterized by a stiffening of the joints due to a tumor at this point. It may result from a strain or injury. If the affection is observed soon after its first appearance



COUNTING HER FLOCK

it may be successfully treated by painting with iodine.

TURKEYS

The turkey is native to America. Four wild species or varieties have been reported as existing in the U.S. in the early days, but probably all four were descended from the Mexican wild turkey. The wild turkey is still a noble game bird in many States and is frequently used for infusing new blood and hardiness into the domesticated varieties. Tradition and excellence unite in placing the turkey above all other birds to grace the table at Thanksgiving and Christmas, and those seasons usually mark the highest prices for this fowl. But of late years the turkey has become practically a year-round meat delicacy.

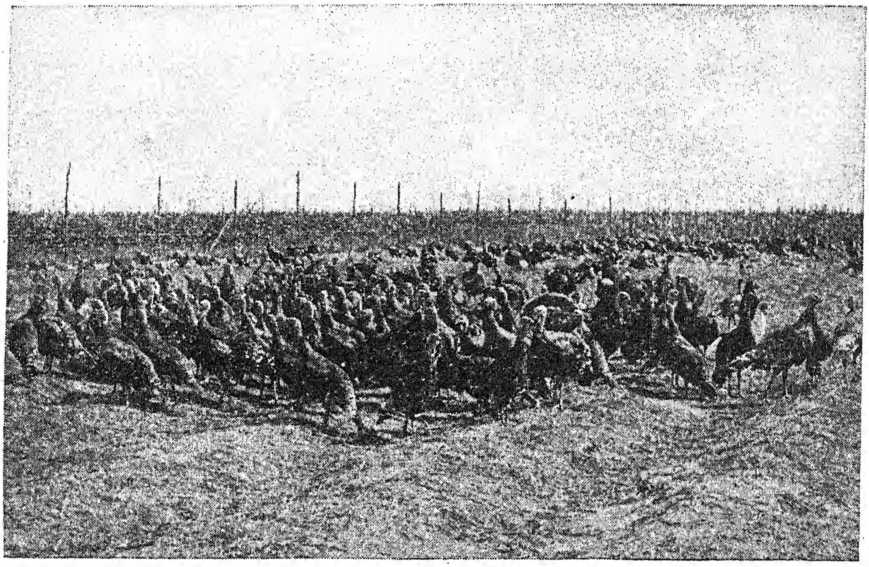
Six standard breeds of turkey are grown in this country, of which the Bronze, White Holland and Narragansett are leaders, while the Black, Slate and Bourbon Red are to be seen in smaller numbers.

The BRONZE is the largest, most vigorous and most familiar breed, and most nearly resembles the wild species. The adult gobbler weighs up to 36 pounds and the hen 20. It seems to be a little more resistant to diseases than other breeds.

The WHITE HOLLAND turkeys are good layers but occasionally do not want to sit early in the season. It is a very beautiful bird in its pure white plumage. This white variety is supposed to have originated as a sudden mutation from the wild form or from the Bronze.

The NARRAGANSETT has a metallic black plumage with gray edging, with none of the iridescence of the Bronze. In size it comes between the White and Bronze breeds. The Narragansett, as the name might indicate, became a favorite bird in Rhode Island, but has been largely replaced by the Bronze in other localities.

According to the 1940 Census 28 million turkeys were raised in the U.S. during the previous year on 443,000 farms. Texas leads in turkey production, followed by California, Oklahoma, Minnesota, North Dakota, South Dakota, Kansas, etc. The breeding stock retained on farms number about 4½ million. While turkeys are raised in every part of the country, what might be called the turkey belt of the U.S. extends from Minnesota to Texas.



TURKEYS RAISED IN CONFINEMENT

As was the case with chickens and ducks, turkeys were formerly raised merely as a small side line on general farms. It was stoutly maintained to be impossible to raise them successfully in houses or in confinement. Early experiments indicated that the eggs of turkeys laid in confinement were infertile to the extent of 50 per cent. Turkeys naturally took to trees for roosting places and,

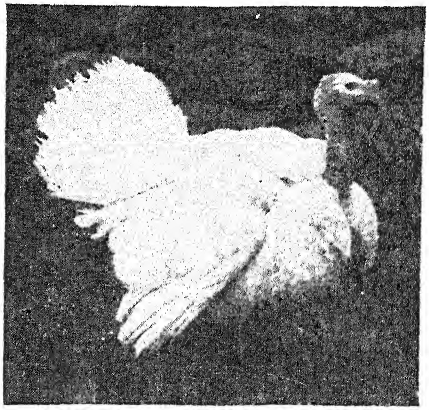
after they had "thrown the red," asked little of man for care or further provision of food. In Rhode Island it was reported that turkeys allowed to roost in trees kept in a more thrifty condition than when forced to roost in even the most comfortable modern poultry houses. It was concluded, therefore, that turkey raising simply demanded care in feeding and management of the young poults, and that after they had become partly developed the less attention given them in the way of buildings and confinement the better. Under such a system, or lack of system, turkey raising could never be anything but an incidental feature of farming.

The turkey hens are extremely furtive and secretive in choosing a place for a nest. These nests might not be easily found by the farmer, but the eggs and the young poults become the prey of prowling animals. Moreover the hen turkey, with a certain lack of maternal wisdom, was prone to take her young along with her as soon as they could walk, on her early morning forays in search of grasshoppers and other provender. Such journeys were often fatal to the little poults since they are extremely sensitive to wet and cold for the first 2 or 3 weeks.

In order to collect the eggs regularly and hold them for incubation, it is necessary to keep the breeding flock in confinement during the laying season. The Kansas Station found that crops grown on soil deficient in manganese when fed to turkeys may reduce the fertility of the eggs to a very low level and that it is necessary in such localities to add 8 ounces of manganese to each ton of the mash feed. The mash recommended for laying turkeys contains ground corn, wheat and oats, bran and alfalfa leaf meal, together with meat scraps, fish meal, soybean meal, lime salt, fish oil and a trace of manganese sulphate.

Turkey eggs require turning 3 or 4 times a day during the early stages of incubation. Brooder equipment for turkeys may be identical to that for chickens, and the same is true for feed troughs, water fountains and sanitation. A temperature of 90° to 95° at the edge of the hover is satisfactory. Poults hatched in April or May in Kansas require heat in the brooder for about 6 weeks. "When poults no longer require supplementary heat they may be turned out to range. The plot of ground selected for this purpose should not have been frequented by any other kind of poultry for at least 3 years."

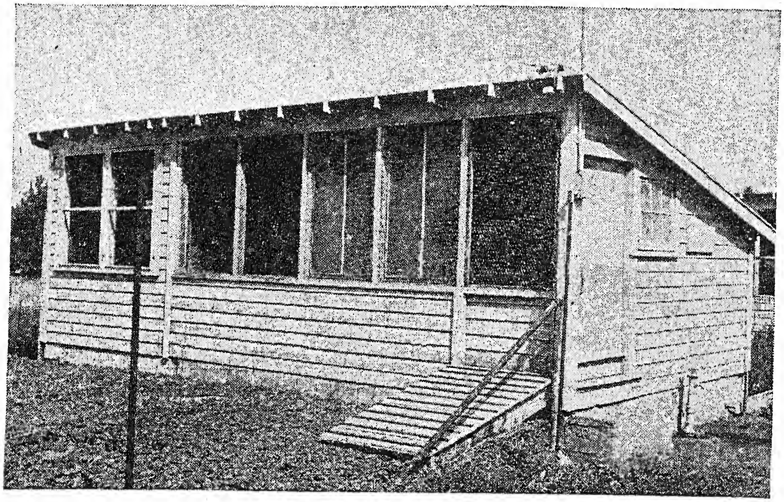
The Kansas experience gives no support to the notion that turkeys should be fed a special fattening ration for a few weeks before marketing. The regular mash ration may be continued.



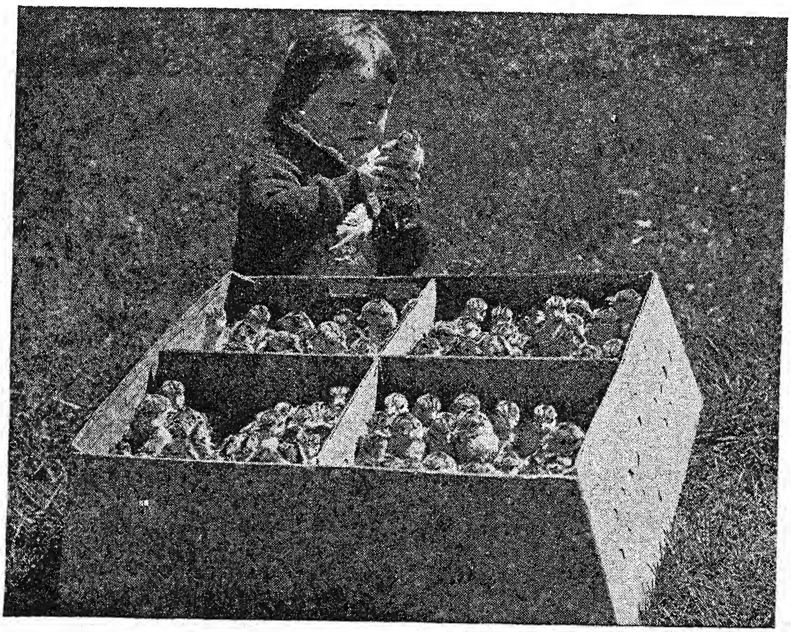
WHITE HOLLAND GOBBLER

In tests in Washington, turkeys that had been fed a high protein ration up to 10 weeks of age consumed less protein from that time to market maturity. In a comparison of the effect of various grains upon the quality of the meat in Wyoming, it appeared that oats produced a better aroma in the roasted fowl, that corn-fed birds were slightly tenderer, and that oats and corn produced a relatively soft body fat. When yellow corn was compared with proso millet in North Dakota in turkey rations, the results were in favor of proso millet. The regular dry mash without further manipulation proved superior to the same material molded into pellets. The New Jersey Station recently reported results of a comparison of two methods of handling turkeys, semi-confinement in fenced yards with some green feed vs. complete confinement on wire sun porches and roosting shelters. "Turkeys reared in total confinement present special problems to the growers which include deformed heels, legs and feet, breast blisters and feather picking." Overcrowding seems to be one cause of feather picking. The birds apparently use each others' tail feathers as a means of cleaning their beaks after eating the mash. Tightly stretched wires over the feeding troughs supply the turkeys with suitable beak wipers.

Sanitation in turkey quarters requires the same treatment as needed in chicken



TURKEY BREEDING HOUSE IN NEBRASKA



A BOX OF TURKEY POULTS

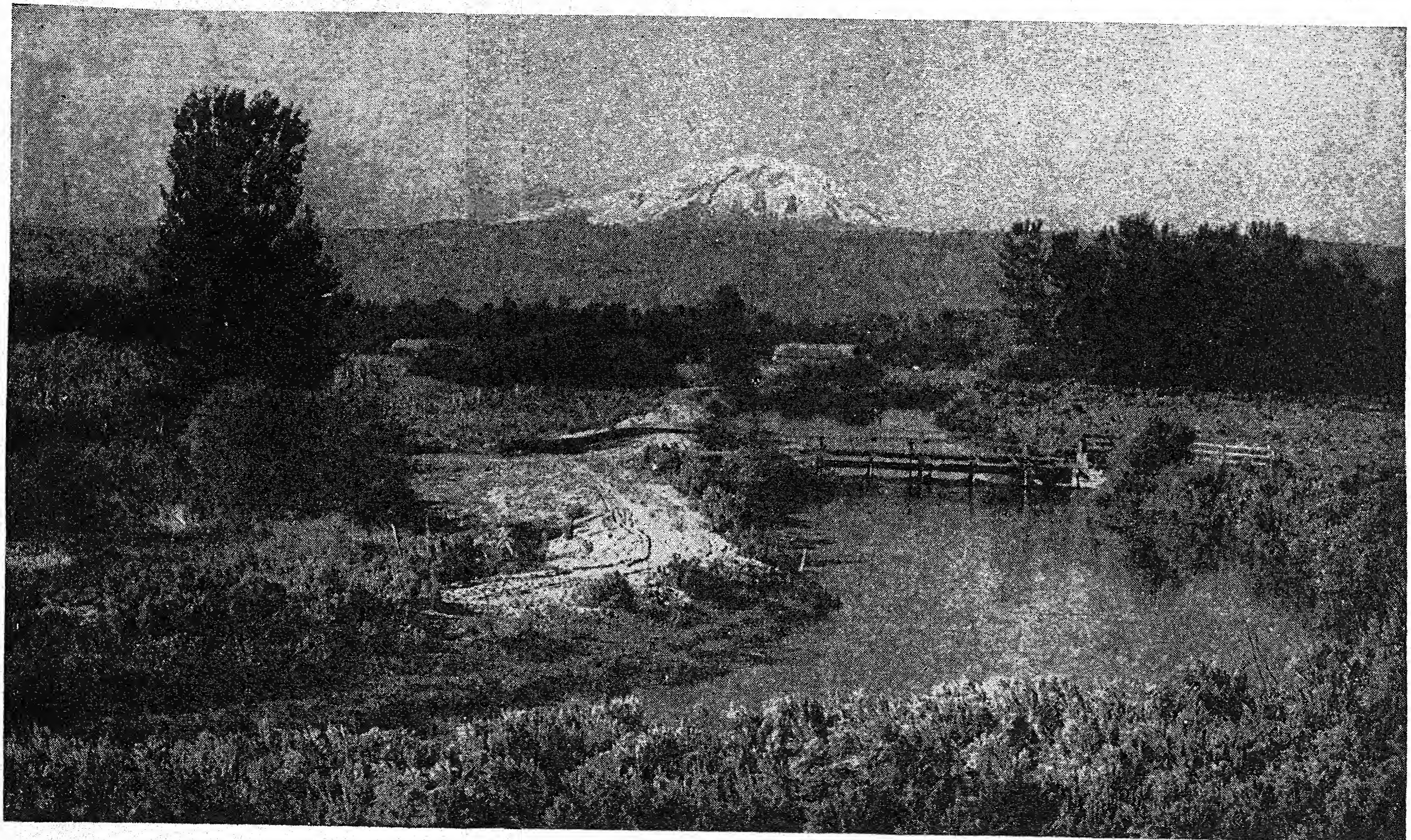
houses. Concrete floors may be sterilized with the blow torch. At the end of each brooding season the houses must be thoroughly cleaned, then scrubbed with a hot lye solution, then sprayed with cresol or other equally good disinfectant. While in operation the brooder houses should be cleaned and the litter changed once a week.

Diseases. Turkeys are attacked by most of the diseases that trouble chickens. These diseases have been discussed in connection with chickens. Blackhead is especially serious in turkeys. The disease is caused by a protozoan parasite (*Histomonas meleagridis*) which attacks the intestines and liver and becomes widely distributed by means of the droppings of infected turkeys. Blackhead attacks young birds as well as mature fowls. Symptoms are profuse diarrhea and often a discoloration of the head which gives it its name. Since both adult chickens and turkeys may be carriers of blackhead, the Nebraska Station recommends as preventive measures, artificial incubation, brooding in a strictly isolated enclosure, keeping poults at least to 12 weeks of age on ground not contaminated by chickens or turkeys, and the use of feeding and watering equipment especially designed to prevent the food and water from being befouled. There is no cure for blackhead. Sick birds should be isolated and destroyed, as well as all fecal material.

For roup, gapes, intestinal worms, cholera and tuberculosis of turkeys *see* under *Chickens*.

PART VII

DRAINAGE, FERTILIZERS, IRRIGATION, SOILS, Etc.



MT. ADAMS AND IRRIGATION CANAL IN YAKIMA VALLEY

DRAINAGE, FERTILIZERS, IRRIGATION, SOILS, Etc.

DRAINAGE

Drainage and irrigation are the two sides of the problem of artificial watering in arid regions. Applications of 6 inches to a foot of water at a time, with repetitions to total a depth of 3 to 6 feet or more in a single season may lead to serious waterlogging and alkali troubles in irrigated regions. Drainage is an absolute requirement to prevent such a disaster which may mean that the farm is out of use for a season or two until it is reclaimed by proper drainage. Such has been the experience on thousands of acres of the irrigation enterprises under federal as well as under private control. On the Elephant Butte project in New Mexico and Texas after the havoc caused by alkali had become only too apparent it was necessary to dig 260 miles of open drains, 10 feet deep and 12 feet wide at the bottom, to carry out of the 75,000 acres of land in the project 270,000 acre-feet of strongly alkaline water annually, containing 400,000 tons of alkali salts.

On the Cache la Poudre irrigation district near Greeley, Colorado, the alkali threat was obviated by taking time by the forelock. An elaborate tile drainage system was put in operation by the farmers 40 years ago and still works perfectly. Tiles were laid so as to pick up the seepage from local storage reservoirs and from artesian flow. The tiles were laid at a depth of 4 to six feet, the largest being 18 inches in diameter, but 90 per cent of them not over 6 inches. This system of tiles is so placed as to carry the surplus water down the natural slope of the valley, bringing the water to the surface at intervals where it is emptied into irrigation canals and thus used over and over to water the lower-lying farms.

More or less elaborate systems of drainage have long been put in practice on various kinds of agricultural land. The value and necessity of drainage have perhaps not been so well recognized as those of irrigation in arid regions. The area of arid land which has been reclaimed by irrigation up to the present time probably does not exceed that of swampy regions which could be reclaimed by a proper system of drainage. The purposes of drainage are manifold. In alkaline soils, especially where irrigation is practiced, a system of drainage is the only efficient remedy for removing the excess of alkali from the soil. In swampy land drainage is necessary in order to make the soil sufficiently firm and dry to be cultivated.

In order that the soil condition shall be favorable for vigorous plant growth it is necessary that the texture of the soil be sufficiently loose and the upper layer sufficiently dry to permit a perfectly free circulation of air down to the depths at which the majority of the plant roots are found. A free circulation of air is required in order to carry oxygen, nitrogen and carbon dioxid, all of which are necessary for various reasons to the most active production of plant substance. It will be readily understood that air cannot circulate in soil which is already saturated with water.

By a system of underdrainage the level of the ground water is lowered, the upper layers of the soil become drier, and cracks are formed so that air is admitted more freely. Such ventilation is especially necessary in clay and other heavy soils.

By lowering the level of the ground water in the soil, favorable conditions are furnished for the deeper penetration of the roots of plants, and as a result the plants are better able to withstand drouths which may occur later in the season. The power of the soil for taking up water by capillary action is greatly increased by withdrawing the underlying body of water, and in times of drouth the plants are able to obtain more water for growth than under conditions where the soil was so moist during the early stages of growth that the root development was confined to the superficial layer of the soil. With well-drained soils farm work such as plowing and cultivating can usually be commenced 10 days to 2 weeks earlier in the spring than on undrained land and can be continued that much longer in the fall.

The soil is made warmer by a proper

system of drainage. This phenomenon is due to 2 or more effects of drainage. It is well known that the temperature of water is raised with much greater difficulty than that of soil or other dry substances. As the result of removing the water from the surface of the soil by drainage, the soil absorbs more heat in early spring; it is thus possible to sow seed under favorable conditions earlier on drained than on undrained soil. The most important cause of the coldness of wet soils consists in the fact that in such soils the surface evaporation of water is extensive, and the heat which has been absorbed is lost during such evaporation. This is in accordance with the well-known phenomenon that all bodies are rapidly cooled by the evaporation of water from the surface. Observations have shown a difference in temperature varying from 2½° to 12½° F. between drained and undrained soils of the same sort in the same locality. The importance of securing as high a temperature as possible in soils in early spring cannot be overestimated. If the soil is too cool various seeds may fail to germinate, or may produce only weak and stunted plants. With the majority of cultivated plants little active growth takes place until the soil has attained a temperature of 48° F., or higher. The difference in the length of time required for seeds to germinate in cold and warm soils is very striking, and may make the difference between a profitable and an unprofitable crop.

All agricultural soils need drainage, but the majority of them are sufficiently drained by natural means. Experiments have shown that the extent of the profitable application of a system of drainage has perhaps been underestimated. Loose, sandy soils, in which the level of the ground water is very deep, naturally do not require drainage. The same is true of the soils of the arid and semi-arid regions, provided an excess of alkali is not present. In such soils there is no distinction between soil and subsoil, and as a result the level of the ground water is under ordinary circumstances very low. Steep side-hills may be profitably drained with broad open drainways, for the purpose of preventing excessive erosion and consequent loss of the fertile superficial layer of the soil. Those lands which are periodically inundated by floods or are artificially flooded for various purposes, as in the case of cranberry bogs, require drainage in order to prevent stagnation of water in the soil and the exclusion of the various gases of the air. Tracts of land lying somewhat low as compared with the surrounding land and receiving surface drainage or water by seepage from the higher land almost invariably require drainage.

There are 2 systems of drainage which are in general use. One consists in digging open ditches which carry the water from the highest part of the land to be drained to the lowest point, where it is discharged; and the other system in the use of tile drains placed at various depths beneath the surface. The use of open ditches is not so satisfactory as tiles, for several reasons. Superficial soil may be washed off into such ditches and lost, and in times of flood they have a tendency to increase the flood rather than to regulate the flow of water. Instead of bare ditches which will soon be eroded into ugly gullies, the natural shallow-channeled watercourses should be utilized for carrying away the surplus water from occasional downpours. But these channels should be kept covered with their natural or seeded grass and should never be plowed. Tile drains, on the other hand, do not increase the height of spring floods to any great extent, and serve as a check upon floods which may arise later in the season from excessive rainfall. The restraining influence which tile drains exercise is due largely to the greater water absorbing capacity of drained soils.

Tile should be placed at depths varying from 2 to 4 feet beneath the surface, depending upon the character of the soil. In soils which are normally moist during the whole season the tile should be placed at a greater depth, while in soils which are too wet only in the spring it may be undesirable to place the tiles lower than 2½ or 3 feet. The size of the tiles used will naturally vary according to the amount of land which is to be drained. It is generally estimated that a 7-inch tile will successfully drain 60 acres of land. It is ordinarily not advisable to use tiles of a smaller size than 3 inches in diameter, since smaller tiles are very apt to become clogged up by silt. They should be squarely and evenly cut across both ends and without collars, and should be placed in close contact end to end. No space should be left between the tiles for the reception of the water; water penetrates the walls of the tiles with considerable rapidity, and if spaces are left the soil may be carried into the tiles and clog them up. Care should be exercised to secure a proper grade for laying the whole series of tiles for draining a given area. With a

grade of 2 inches per 100 feet successful conditions are furnished; if the grade is less than that, more care must be exercised in making the grade perfectly uniform, in order to prevent the accumulation of silt at points where the grade changes. The lines of tiles should be laid at intervals of 50 to 100 feet, depending on the character of the soil. The experiments which have been conducted at the stations in various States have shown that profitable results may be obtained from a system of drainage in a great variety of soils. In the sugar soils of the Southern States it has been estimated that more benefit is derived from drainage than from fertilizing.

FERTILIZERS

Fertilizers are used in every state to replace the plant food and organic matter taken from the soil by continuous cropping or erosion or leaching of the soil. About 8½ million tons of fertilizer materials are applied to the soil in the United States annually. The heaviest applications are made in the Southern States and generally in trucking regions of the Eastern and Northern States. North Carolina heads the list with the use of a million tons per year. Commercial fertilizers are easier to handle than barnyard manure, are more rapid in their action and are often required to supplement barnyard manure, which does not always furnish food to farm crops in the right proportions.

A "complete" fertilizer contains all 3 elements—nitrogen, phosphoric acid and potash. Most of the trade brands of fertilizers sold on the market are complete fertilizers. The amount of each of these elements required by different crops varies greatly. It may be, also, that a soil is already sufficiently fertile in nitrogen to produce a maximum crop, but is lacking in potash and phosphoric acid. It is plain that in such cases a complete fertilizer will not be required. One containing potash and phosphoric acid will be sufficient, and if nitrogen is added it will be of no benefit to the plant and a loss financially. A knowledge of the fertilizer requirements of different plants, of the soils on which the plants are to be grown and of the best forms of fertilizers to apply, therefore, becomes essential to the intelligent use of commercial fertilizers. In this work the most effective fertilizers for use on the different crops have been considered under the plants themselves and need not be considered here.

Only general directions can be given as regards the kind of fertilizer likely to be of greatest value on the different soils. Sandy soils are likely to be deficient in all 3 essential elements. Clayey soils are usually abundantly supplied with phosphoric acid and potash, particularly the latter. Limestone soils generally contain sufficient phosphoric acid. Many black soils are sufficiently rich in nitrogen, but are lacking in potash and phosphoric acid. The only sure way, however, of telling exactly what a soil needs is to grow a crop on it and apply the different elements and combinations on different parts of the field and note the results. There are many different forms of nitrogenous, phosphatic and potassic fertilizers now on the market. The sources, value and uses of some of the more important of these are noted below.

Nitrogenous Fertilizers. The effect of nitrogenous fertilizers is to greatly promote the growth of stems and leaves of plants and to retard the development of flowers and fruit. An abundance of nitrogen in the soil is shown by deep green colored foliage. If nitrogenous fertilizers are applied at about the time the plant should bloom new stem and leaf growth is likely to follow and the blooming period be checked. A lack of nitrogen in the soil is generally indicated by a spindling growth of a yellow, sickly appearance. Nitrogen is the most expensive of the essential fertilizers. The more usual nitrogenous fertilizers found on the market will be briefly characterized below.

Nitrate of Soda. This fertilizer is also known as Chili saltpeter. It exists in large deposits in Chili and Peru. As put upon the market it is quite uniform in composition, containing about 16 pounds of nitrogen in each 100 pounds of nitrate of soda.

Nitrate of soda readily dissolves in water and is immediately available for the use of plants. Its effects may sometimes be seen within 24 hours. It forms no insoluble compound with the soil constituents, and is therefore easily washed out of the soil when applied in excess of the needs of the plant. For this reason nitrate of soda should not be applied to crops much before the time they will be able to use it, and better results are usually obtained if it is applied in small amounts at 2 or 3 different times during the growth of the plant rather than all at once. It should be applied to the surface soil and lightly cultivated in or may be applied in irrigation water. Nitrate of soda is one of the most effective nitro-

genous fertilizers when properly handled. It should seldom be used in excess of 300 pounds per acre, and ½ of this amount is usually sufficient.

Sulphate of Ammonia. This is the most highly concentrated form of nitrogen used for fertilizing purposes. It is formed as a by-product in the manufacture of illuminating gas and contains on the average 20 pounds of actual nitrogen in each 100 pounds of material. It acts less rapidly than nitrate of soda, but much more rapidly than any of the organic forms of nitrogen described below. It is readily soluble in water and easily diffused in the soil. The nitrogen in sulphate of ammonia is about equal in fertilizing value to the nitrogen in nitrate of soda. In a wet season it is likely to be more beneficial than nitrate of soda. Like the latter, it should be applied to the soil in the spring rather than in the fall, and preferably in small amounts as the plants require it. Usually not more than 260 pounds of sulphate of ammonia should be applied per acre, and most crops will not require this amount.

Dried Blood. This is one of the most important of the organic nitrogenous fertilizing materials, as it is the richest in nitrogen and decays rapidly in the soil. It is obtained from the large slaughtering establishments and is made by drying and grinding blood. There are 2 grades, the red and the black. The red blood is the richer in nitrogen and obtained by drying with hot water. The black is dried at a higher temperature and contains but 6 to 12 per cent of nitrogen, while the red contains 13 to 14 per cent. The black blood also contains some phosphoric acid, sometimes as much as 4 per cent, while the red contains but a trace.

Tankage is also a fertilizing material obtained from slaughter houses. It is variable in composition, being made up of refuse meat, fats, intestines, including contents, hair, etc. It is usually cooked, dried and ground and sold on the basis of the nitrogen and phosphoric acid it contains. Concentrated tankage contains 10 to 12 per cent of nitrogen and but a small amount of phosphoric acid. Crushed tankage varies in the amount of nitrogen it contains, from 4 to 10 per cent, and may contain as much as 10 per cent phosphoric acid. Crushed tankage has also given good results as a pig feed.

Fish. Fertilizers known as dried fish, ground fish and fish guano are derived from the by-products of fish canning establishments or fish packing houses. They consist largely of the skin, bones and offal. When dried and ground these fertilizers contain 7 to 8 per cent of nitrogen and 6 to 8 per cent of phosphoric acid, and are nearly as valuable as dried blood or tankage.

Cottonseed Meal is the residue which remains after the oil has been extracted from cotton seed. It is a rich cattle food and one of the best of the vegetable nitrogenous fertilizers. It contains about 7 per cent nitrogen, 3 per cent phosphoric acid and 2 per cent potash. The nitrogen is in a less available form than in dried blood and the various meat and fish meals. The whole cotton seed is sometimes used as a fertilizer. It contains considerable oil which has no value as a fertilizer, and is, therefore, not so valuable ton for ton as cottonseed meal. When these products can be obtained at a moderate price they constitute an excellent fertilizer and are largely used in the South.

Castor Bean Pomace is made from castor beans after the oil has been extracted. It contains 5 to 6 per cent nitrogen, 2 per cent phosphoric acid and about 1 per cent of potash, and makes a valuable fertilizer when it can be bought at a reasonable price.

Phosphatic Fertilizers. The role of phosphorus in the growth of plants is not wholly understood, but no plant will grow without it, and it seems to be intimately connected with the production of seed. There are a number of different materials used to supply phosphoric acid to plants, but lime compounds of phosphoric acid are most common. Phosphoric acid exists in fertilizers in 3 forms: "That soluble in water and readily taken up by plants; that insoluble in water, but still readily used by plants, also known as 'reverted'; and that soluble only in strong acids and consequently very slowly used by plants. The soluble and 'reverted' together constitute the 'available' phosphoric acid." Phosphoric acid as it exists naturally in bones and rock is insoluble in water, and only slowly available to plants. When rocks, bones or other materials containing insoluble phosphoric acid are treated with sulphuric acid the phosphoric acid is rendered soluble in water and readily available to plants. Such phosphates are usually known as superphosphates, or acid phosphates, and these are the most valuable forms of phosphatic fertilizers.

Phosphatic fertilizers may be applied to the soil at any time, since they are not washed out by rains or otherwise. The insoluble forms should be applied some

time before the crops are sown in order that they may become available for the use of the plants.

Bones. Ground raw or steamed bones are used largely as phosphatic fertilizers. They contain 3 to 5 per cent of nitrogen and 20 to 25 per cent of phosphoric acid. The phosphoric acid in them is in an insoluble form, but when the bones are ground they readily decay in the soil and the phosphoric acid in them becomes available to the use of plants. The finer the bones are ground the more rapidly they decay, and hence the more valuable they are. The steamed bones contain 1 to 2 per cent less nitrogen than the ground bones, but decay more rapidly in the soil. Bone black or bone charcoal is used first in refining sugar. When it becomes unfit for this purpose it is used as a fertilizer. It may contain 30 per cent of phosphoric acid in a somewhat less available form than fine ground bone.

Rock Phosphates. These are also known as mineral phosphates and are generally designated by the districts from which they come as Florida rock, South Carolina rock and Tennessee rock. Other forms of mineral phosphates are the apatites of Canada, phosphatic slags, etc. The phosphoric acid in all these is in an insoluble form, and in the untreated state they are not much used as yet, even when finely ground. They constitute the chief raw materials, however, from which superphosphates or acid phosphates are made. They contain 25 to 30 per cent of phosphoric acid. When finely ground they are often known by the name of floats.

Superphosphates. Also known as acid phosphate, dissolved bone, or bone black, dissolved rock, etc. They are made by grinding bones and the various rock phosphates and other like materials fine and treating with sulphuric acid. This changes the insoluble phosphoric acid into soluble forms which can be readily used by plants. The amount of phosphoric acid in superphosphates varies from 12 to 18 per cent. "The superphosphates made from bone black and bone ash differ from the mineral superphosphates in showing a higher content of 'available' phosphoric acid, an average of 16 per cent, which is practically all soluble." Bone superphosphates contain some nitrogen also, and are sometimes referred to as ammoniated superphosphates, or other like terms.

Thomas Slag. Also known as odorless phosphate, phosphoric slag, basic iron slag, etc. This is a by-product in the manufacture of steel and iron, consisting largely of phosphate of lime. The finely ground slag contains 19 to 20 per cent of phosphoric acid, 6 to 7 per cent of which is available. Thomas slag is not used in the manufacture of superphosphates, and should therefore be very finely ground, as the value of the material depends largely upon its fineness. Experiments in Massachusetts indicate that Thomas slag and dissolved bone black are about equally effective. It appears especially suited for leguminous crops and may be applied at the rate of 600 to 1000 pounds per acre.

Potash Fertilizers. Potash fertilizers are primarily concerned in the production of starch in plants and the development of fruits and seeds. Nearly all forms of potash are soluble in water. The principal materials used as potash fertilizers are the sulphate and muriate of potash, kainit, cottonseed hull ashes, wood ashes and tobacco stems. The potash in all these is about equally available to plants. Potash used as a fertilizer is readily fixed in the soil and is not leached or washed out. It is usually recommended that potash fertilizers be applied broadcast and promptly harrowed in.

Muriate of Potash contains 50 to 53 per cent of actual potash. A much higher grade is sometimes found on the market. The potash fertilizer is largely used for all farm crops except tobacco, potatoes and sugar beets. With these crops the quality is injured by the use of the muriate.

Sulphate of Potash. This is also a product of German mines. High grade sulphate contains from 48 to 53 per cent actual potash. Some lower grades contain but 30 per cent of actual potash. Sulphate of potash is preferable to muriate in growing tobacco, potatoes and sugar beets. There is a double sulphate of potash and magnesia. These usually contain 26 to 28 per cent of actual potash, and in addition considerable amounts of sulphate of magnesia.

Kainit. This is the most commonly used crude potash salt. It contains from 12 to 14 per cent of actual potash, and in addition considerable amounts of common salt, gypsum and magnesia.

Wood Ashes contain when unleached from 4 to 7 per cent of potash in one of the best forms for the use of plants. Leached ashes contain but 1 to 2 per cent of potash. Soft wood ashes are also poor in potash, and coal ashes are practically worthless as regards potash. Wood ashes contain also about 2 per cent of phosphoric acid and 32 per cent of lime. Lime kiln ashes contain on an average but

1.5 per cent of potash and 1 per cent of phosphoric acid. Ashes constitute one of the best forms of potash fertilizers and should be carefully husbanded under shelter away from leaching rains.

Home Mixing of Fertilizers. As before noted most of the commercial fertilizers placed on the market are complete fertilizers containing phosphoric acid, potash and nitrogen. The buyer must pay for all these ingredients, although they may not be mixed in the most suitable proportions for the crop he wishes to grow, and it may be that his soil does not require all 3 ingredients. The mixed fertilizers also cost more per ton than the several ingredients purchased separately. Many farmers have therefore taken to the practice of buying the various ingredients separately and mixing themselves. It is economy to do so, and generally gives very satisfactory results. The home mixing has an educational value as well.

In buying fertilizers it is usually economy to get the concentrated forms. There is less bulk to handle. They should be in as dry and finely pulverized condition as possible. They handle better and contain a larger percentage of valuable materials than when lumpy and wet. Usually farmers can club together and get reduced rates. In mixing place the bulkiest fertilizer on a tight barn floor first and spread out in a layer 4 to 8 inches deep. On top of this spread layers of the remaining material and then thoroughly mix by shoveling over. If the material is not thoroughly mixed by this method it can be thrown through a sand sieve. The bulk may be increased by adding dry road dust to the heap.

Inspection. In practically all the States where fertilizers are sold laws have been passed which require that each brand put upon the market contain a guarantee as to the amount of phosphoric acid, nitrogen and potash it contains and the form in which it is found. Usually an experiment station officer is charged with the details of collecting and sampling fertilizers put upon the market to see that the laws of the State are complied with. These analyses are published in bulletins from time to time and can be obtained by any farmer free upon application. Such bulletins usually contain comments on the actual cash value of the different fertilizer brands and other valuable information regarding fertilizers. Most States require a license fee for each brand of fertilizer put upon the market.

GYPSUM

Also known as land plaster, is a sulphate of lime in combination with water. It contains about 33 per cent of lime, 46 per cent of sulphuric acid and 21 per cent of water. When gypsum is burned, water is driven off and plaster of Paris formed. Gypsum deposits are widely distributed throughout the United States. The crude product usually contains some impurities. Gypsum is used to some extent as a fertilizer, but its action is not well understood. It appears to have an indirect action, like lime, in setting free plant food, more especially potash. It has a very beneficial action on clover and other legumes, and was formerly used quite extensively as a manure for these crops.

LIME

Lime is of great importance in agriculture, being extensively used as a soil amendment. It is found in the ash of all plants and is an essential constituent of all good soils. It exists naturally as limestone, shells, marl, chalk, coral, etc. Quicklime or caustic lime is made by burning limestone or any carbonate of lime in kilns at a very high temperature. Quicklime is more energetic in its action than the carbonates, which are termed mild lime. When quicklime is exposed to the air it gradually slakes and breaks down into a fine powder, when it becomes carbonate of lime or mild lime.

The specific action of lime in promoting plant growth is not well understood. In a mechanical way it acts on the texture of soils. It tends to make heavy clay soils more open, porous and friable and reduces their tendency to puddle. Loose sandy soils are made more compact when treated with lime. In a chemical way acid soils, like many freshly drained muck lands and some uplands, are sweetened by the use of lime and made capable of producing more useful crops like the clovers. Lime also appears to act on the insoluble compounds of potash and phosphoric acid in the soils, making these valuable ingredients more available for the use of plants. It decomposes organic matter in the soil and tends to promote nitrification and to increase the power of the soil to fix and retain such valuable fertilizing materials as ammonia and potash. In meadows weeds like sorrel are lessened and the growth of more valuable forage plants encouraged by the use of lime.

Lime and green manures are considered especially valuable in renovating worn soils. On heavy soils quicklime is of

greatest value, and may be applied at the rate of 20 to 40 bushels per acre. It is advisable to begin with a moderate application first and see how it acts. Many soils are already sufficiently supplied with lime. On the other hand, some soils which are high and dry appear, nevertheless, to be sour, and are greatly benefited by lime. On lighter lands which are poor in vegetable matter mild lime or small applications of caustic lime are likely to give the best results.

Lime is best applied slaked. This is best done by pouring water on it and immediately covering it with earth so that the air cannot get to it. In a few days it will be in a finely pulverized condition and most suitable for spreading on the land. Lime is somewhat soluble in water and tends to sink down into the ground. It should therefore not be applied until the ground is partly prepared, when it should be broadcasted and cultivated in the surface soil. On permanent grass lands the lime should be applied in the fall.

Lime should not be mixed with nitrogenous fertilizers, including barnyard manure, poultry manure, etc., as it is likely to injure them by driving off ammonia.

Stone lime weighs about 93 pounds per bushel. This will make about 3 bushels of slaked lime, weighing 45 pounds per bushel each. Unslaked oyster shell lime weighs about 60 pounds per bushel, and when slaked 40 pounds per bushel.

BARNYARD MANURE

It has been calculated that if all the solid and liquid manure from farm animals could be collected and carefully saved it would have an approximate annual value as follows: Horses, $27 per head; cattle, $19; hogs, $12; sheep, $2. Also that during a winter of 7 months a small farm carrying 4 horses, 20 cows, 50 sheep and 10 pigs would produce a qauntity of manure having a value of $250. These figures indicate that the manure pile has a greater money value than many farmers assign to it.

The composition of barnyard manure and its character varies greatly with (1) The kind and age of the animal producing it; (2) the quality and quantity of food eaten; (3) character and amount of litter used; (4) method of preserving the manure, and (5) the length of time the manure is kept. On the average a ton of good mixed barnyard manure will contain about 10 pounds of nitrogen, 5 pounds of phosphoric acid and 10 pounds of potash.

Urine. The urine of animals is much richer in fertilizing ingredients than the solid matter excreted. It is especially rich in nitrogen and potash, but contains little more than a trace of phosphoric acid. or this reason the best results will be obtained by using the urine and solid excrement together.

Kind of Manure Produced by Different Animals. The manure from growing animals and milch cows is poorer in fertilizing ingredients than that from mature and fattening animals. Full grown animals neither gaining nor losing in weight excrete practically all the nitrogen, potash and phosphoric acid consumed in the food eaten; growing animals, milch cows, etc., excrete 50 to 75 per cent, and working and fattening animals 90 to 95 per cent. The characteristics of the manure produced by different farm animals also very greatly. Horse manure is a dry manure of loose texture and quite uniform composition. It decomposes or ferments readily, producing a large amount of heat, and unless well preserved is likely to lose a considerable part of its nitrogen. It is classed as a hot manure and is largely used in the preparation of hotbeds. Sheep manure is quite dry and is commonly the richest of farm produced manures. Like horse manure, it undergoes fermentation easily and is classed as a "hot manure." Pig manure decomposes slowly and is classed as a "cold manure." Cow manure is poorer in fertilizing materials than any of the above, contains considerable water, decomposes slowly and is also classed as a cold manure. Poultry manure is the richest of farm manures, especially in nitrogen and potash, since with this animal the urine and feces are excreted together. Absorbents should be used in its preservation, since it decomposes readily, losing nitrogen. A ton of poultry manure has about double the fertilizing value of a ton of sheep manure.

Quality of Manure as Affected by Food. The composition of the food fed greatly influences the quality of the manure produced. Concentrated foods, like meat scrap, cottonseed meal, linseed meal and wheat bran, produce the richest manure; the leguminous plants, like clover, alfalfa and cowpeas, stand next; the cereals third, and root crops last.

Litter in Manure. Litter like straw, sawdust, peat moss, leaves, etc., is used in stables primarily to furnish a clean, comfortable bed for animals. It also absorbs the liquid portion of the manure and prevents its loss by drainage, makes the manure easier to handle and tends to check

and control its decomposition. Too much bedding should not be used, as it tends to dilute the manure and increase the expense of handling. The best materials for bedding, so far as concerns the composition of the manure, are straw, dead leaves, and peat. The best absorptives are peat moss, peat, and sawdust. Straw is better than leaves.

Fermentation of Manure. Manure left in large piles rots and the bulk decreases in weight and size. The rotting is the result of fermentation and decomposition caused by bacteria. Half-rotted manure is usually of greatest manurial value, and well-rotted of least value, while fresh manure is intermediate. One class of bacteria works in that portion of the manure accessible to air. They change the nitrogenous portions of the manure into soluble nitrates, the form in which nitrogen is most readily available to plants. Another class works in the interior of the pile away from the air and is instrumental in breaking up the more complex material of the manure. Considerable heat is generated by the fermenting manure. In the outer portions of the pile the temperature may rise from 120° to 140° F., or even higher. A temperature of about 131° F. is considered most favorable. The temperature on the inside of the pile rarely rises above 95° F.

A too rapid fermentation of the manure tends to a loss of nitrogen and humus. Fermentation is less rapid in moist compact heaps than in loose open heaps. The common and harmful "fire fanging" is caused by a too rapid fermentation in the absence of sufficient moisture, and may be controlled by sprinkling with water.

Leaching. Experiments have clearly shown that where manure is exposed to the influence of the weather it loses greatly in value through leaching by rain and snow. In loose open piles the loss in fertilizing value may be as much as 50 per cent in 6 months. The manure pile should be kept moist, but should never be placed under the stable eaves. The loss in an open yard will be greatly reduced if the pile is well compacted.

Preservation. Fresh manures that undergo rapid fermentation, like horse and sheep manure, should be mixed as soon as possible with some absorbent like litter to prevent the escape of nitrogen. Gypsum sprinkled on the fresh manure and urine is also a popular preservative, and kainit and acid phosphate are used effectively for the same purpose. The gypsum is not effective unless it becomes moist, and kainit must be used with caution or it will injure the feet of animals. If the "cold" cow and hog manure is intimately mixed with the "hot" horse and sheep manure the heap will be made more moist and the tendency of the latter manures to "fire fang" checked.

Covered barnyards for the preservation of manure are recommended. The manure should be spread out evenly and well packed down. The stock will do this, in a measure, if they are allowed to run over it. If open yards are used they should be dished toward the center, the bottom puddled with clay and sufficient litter used to absorb the leachings at the bottom.

Use. Barnyard manure is one of the most valuable of all fertilizers. Not only does it contain all the fertilizing elements required by plants in their growth, but it has a marked beneficial effect on the soil itself, rendering the stored-up food in the soil more available, improving the mechanical condition of the soil, making it warmer and more capable of retaining moisture.

Barnyard manure should be applied when practicable in as fresh a condition as possible. While it is true that the fertilizing constituents of well-rotted manure are more quickly available to plants, "the manure itself is less bulky, easier to distribute, affords a good breeding place for organisms which promote nitrification in the soil, and is less likely to promote rank growth than fresh manure"; nevertheless "fresh manure mixed with the soil readily undergoes fermentation, which not only increases the availability of its own fertilizing constituents, but also assists in rendering soluble the hitherto insoluble constituents of the soil. In fact, even with special precautions to prevent injurious fermentation under the feet of the animals and in the heap, the greatest return is likely to be gotten from manure applied in the fresh condition."

The form in which manure is used is largely influenced by the soil to which it is applied and the crop grown. The mechanical condition of heavy clay soils is lightened by applications of fresh manure. In such soils the manures are likely to decompose slowly, hence they should be applied considerably in advance of the time the crop is planted.

Applying Manures. Barnyard manure should be spread out evenly over the ground when it is hauled to the field and not left in small piles, as is a common practice with many farmers. If fields are available and conditions permit, it is

advisable to draw the manure and spread it as soon as it is made. In winter, time will nearly always be found between the morning and night "chores" to draw out the manure. This will ease up the rush of work and permit of the more timely planting of important crops when spring opens. On light or sandy soils, however, or on steep lands where losses from drainage are probable, manures should be applied only when they can be soon plowed under.

The amount of manure to apply will vary with the condition of the soil. Frequent light applications are better than an occasional heavy manuring. From 8 to 12 tons is a good manuring. On truck soils 20 tons are usually applied and sometimes much more.

Applying Barnyard Manure and Commercial Fertilizers Together. Barnyard manure is largely a one-sided manure, being most valuable for the nitrogen it contains, and is generally referred to as a nitrogenous fertilizer. Numerous experiments have shown that the best results are obtained when barnyard manure and commercial fertilizers are used to supplement each other. On very rich truck lands where the soil is already well filled with humus, commercial fertilizers alone are likely to give the best results; but on ordinary soils the two combined will usually prove more effective than either alone.

Compost consists of mixed and rotted vegetable matter, particularly manure and litter. It is usually made in a convenient level place on puddled clay to prevent drainage. The bottom layer consists of any convenient absorbent like leaves, muck, straw, sod, etc. On this is dumped all the refuse of the farm like manure, weeds, spoiled hay or straw, night soil, sods, leaves and the like. It is desirable to keep it packed down by driving the teams and loads over it and occasionally forking it over. In dry weather the heap should be kept wet down either with water or liquid manure. Compost is of no great importance on the farm, but is very desirable in gardening and greenhouse operations. It is sometimes enriched by composting cottonseed, kainit, ashes, superphosphate, etc. with it. The manure heap should constitute the compost heap of the farm.

Green Manuring. By this term is meant the plowing under of green crops grown especially for that purpose. The object of green manuring is to enrich the soil with nitrogen, add humus to it, improve its physical condition and make more available the mineral foods already in the soil. Green crops are often grown between 2 primary crops to prevent the land from lying bare and leaching. Green manuring is of especial value on poor soils that need rejuvenating to produce profitable crops. On good soils it may not be an economical practice.

Two classes of plants are used for green manuring, those that gather nitrogen from the air and in decay add this valuable plant food to the soil, and those that cannot gather atmospheric nitrogen but simply utilize that already in the soil. The first class is by far the most valuable. It is composed of the leguminous plants such as alfalfa, clover, crimson clover, cowpeas, velvet beans, soy beans, beggarweed, serradella, vetches, etc. To the second class belong such crops as buckwheat, rye, mustard, etc. A good crop of alfalfa, crimson or red clover, cowpeas or velvet beans will contain about 150 pounds of nitrogen, a large proportion of which is obtained from the air. Green manures add no mineral matter to the soil other than that taken from it. They do, however, bring up such foods from the subsoil and store them in the leaves, stems and upper portions of the plant. When the crop is plowed under these materials accumulate in the surface soil, and thus become more available for succeeding crops. Such plants as rye, buckwheat and mustard add absolutely nothing to the soil on which they grow except humus. This, however, is of great value in the improvement of the physical condition of the soil, and for this purpose they may be used until the clovers or some other leguminous plants can be grown. The value of various plants for green manuring is discussed in this work under the plants themselves.

MARL

This term as generally used refers to a mixture of carbonate of lime and clay with more or less sand, which readily falls to pieces on exposure to the air. In Michigan, Wisconsin and other Northern States beds of calcareous shell marls occur in the bottoms of old lake beds or under layers of peat. They are composed of more or less decomposed remnants of small shell animals, and often analyze 85 to 90 per cent fine carbonate of lime. These marls contain practically no potash or phosphoric acid. According to the Wisconsin Station they possess considerable value as a fertilizer on soils deficient in lime or as an amendment to clayey, sandy or peaty

soils. As a soil amendment at least 40 tons per acre should be applied. For the purpose of adding lime to the soil 1 or 2 tons per acre may be sufficient. Farmers possessing marl beds should apply it to a portion of their land and note the result.

Other marls of different geologic origin are classified as clay marls, sand marls, blue marl, green marl, red marl, etc. The green shell marls of New Jersey contain only very small amounts of lime, but also some phosphoric acid and potash. The average of many analyses is 2.2 per cent phosphoric acid, 4.7 per cent potash and 2.9 per cent of lime, all in a very slowly available form. Ordinarily those marls richest in lime are of greatest value as fertilizers.

MUCK

The partially decayed vegetable matter found in low wet places, as swamps and bogs. Fresh muck contains about 75 per cent moisture. The weathered muck is valuable as an absorbent in stables and compost heaps, and is about as rich in nitrogen as barnyard manure, but contains only insignificant amounts of potash and phosphoric acid. Fresh muck is not suitable for use as soon as dug, since the nitrogen in it is then in a very inert form and it also contains considerable amounts of vegetable acids and iron salts. It should be weathered first for 5 or 6 months or composted with lime, ashes or marl. Where a muck bed exists upon the farm it should first be studied with reference to its possible drainage. If it can be drained it is more likely to prove useful where it lies than to use it as a manure for other portions of the farm, since such soils are particularly valuable when properly managed for growing onions, celery, cabbage, peppermint, etc.

Other elements of importance to growth of plants have been the subject of extensive investigation in recent years. Among these chemicals mention should be made of boron, manganese, magnesium, copper, and zinc. In minute quantities or a mere trace these elements may exercise an astonishingly stimulative effect on growth processes, or they may correct or overcome the injurious effects of other compounds. In studying the problem of injury to rape, flax, vetch, lettuce, tomatoes and other crops as a result of overliming, borax proved to be 4 times as efficient for this purpose as zinc, manganese or any other element. But these chemicals used as correctives are themselves harmful if present in the soil to excess.

IRRIGATION

The artificial application of water to growing crops has been practiced since the dawn of history in Africa, Asia and Europe. In the Old Testament we read of irrigation ditches. An inscription on the tomb of Queen Semiramis of Egypt, 2000 years B.C. announces, "I constrained the mighty river to flow according to my will and led its waters to fertilize lands that had before been barren and without inhabitants." Early Spanish settlers practiced irrigation in the southwest. Near Los Cruces, New Mexico, there is a ditch that has been in constant use for 300 years. The Mormons began irrigating as soon as they reached Utah in 1849. The increase in the use of irrigation water has gone steadily forward till at present there are 20,568,000 acres under irrigation, of which 16,777,000 are in privately financed enterprises and 3,791,000 acres in Federal projects. The total area which ultimately may be irrigated on private and Federal projects together is 32,892,000 acres with a total investment of over a billion dollars.

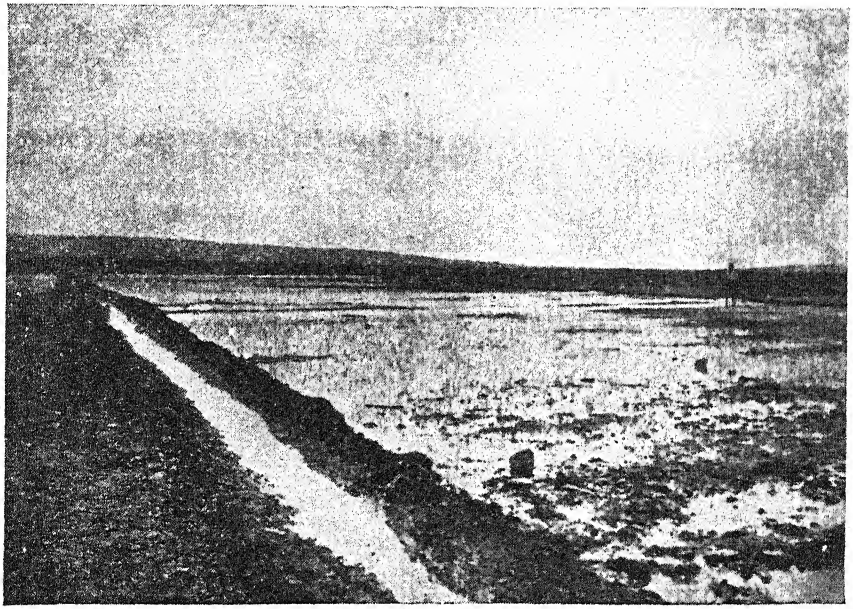
In order that irrigation may be practiced it is necessary that the natural streams have a rather rapid fall. Ditches may then be taken out at points along the streams and by giving the ditches merely enough fall to cause the water to flow, the water may be brought to a much higher level than the river at points a few miles below where the ditch is taken out. If, for example, the fall of the natural stream is 100 feet per mile and the ditch is constructed with a fall of 4 feet per mile, the water in the ditch at a point 1 mile below where it is taken out will obviously be 96 feet above the river. It is thus possible to bring water by gravity upon high bench lands along the river course. The fall of western streams varies from 5 to 120 feet per mile, and that of irrigation ditches from 2 to 4 feet per mile. The greater the fall of the stream, therefore, the shorter the required length of the ditch.

The size of irrigation enterprises may vary from that of a crude wingdam of brush and rocks diverting a portion of a small stream on a private farm for watering a field of alfalfa, to the great privately developed systems along the Cache le Poudre River in Colorado, or to the system of the Gallatin River in Montana and finally to the Grand Coulee on the Columbia River with a dam 3000 feet long, 550 feet high, creating a reservoir 82,000 acres in area and 150 miles long. But in this article we are interested in the agricul-

tural rather than the engineering phases of irrigation.

The fall of ditches depends on the natural grade of the land and on the nature of the soil. In regions where the water carries large quantities of silt, the ditches become obstructed by such deposits till they may break out of their banks, if the water flows too slowly. On the other hand a too rapid fall is to be avoided on account of the danger from erosion in the bottom and sides of the ditches. The same precautions must be observed in construction of laterals and irrigation furrows in the cultivated fields. This requires, on the part of the farmer, sufficient knowledge of surveying to level his land and to run his ditches and furrows with a uniform fall. Otherwise it is impossible to apply a uniform depth of water over the whole field, the result being that some parts of the field are drowned in water while other parts are left thirsty.

In canals of great length the loss of water by seepage and evaporation before reaching the field to be irrigated may become a serious matter. Such losses in a dry atmosphere and loose soil may amount to 50 per cent of the water taken into the canal at its head. All irrigation water, however, carries some silt and canals naturally become lined with the material in the course of time. Otherwise, especially in gravelly soil, it may be wise to line the canals with fine material to prevent seepage. Moreover, quite aside from the possible loss of water, seepage is a source of danger to low-lying land along the course of the canals. The seepage water may appear lower down, sometimes miles away, transforming the land into a marsh. Or where quantities of alkali are found in the lower strata of the soil, the alkali is dissolved in the water and after being carried to the surface by capillary action is left as a white crust or deposit on the ground by evaporation of the water. In this way thousands of acres of land have been ruined after being cultivated for years.



FIRST IRRIGATION IN MONTANA

In fact overirrigation has been the greatest curse of irrigation farming. Homesteaders who came from Central or Eastern States, and who had learned to wait more or less patiently for natural rainfall to water their crops, as soon as they were settled on an irrigation project often plunged into an orgy of water application. As much as 8 to 12 feet of water has been turned onto a crop in the course of a single season under the apparent impression that if a foot of water was good 10 feet were better. On large areas of several irrigation projects the alkali thus

brought to the surface made it impossible to grow crops, and the expenditure for reclaiming the land from alkali nearly doubled the total cost of the project.

In the early days of irrigation attention was devoted to the engineering phases of the problem of where to find the source of water in the mountains and how to bring it down into the valleys and distribute it upon the farms. Later investigators like Dr. John A. Widtsoe of Utah, tried to find the answers to the questions how much water do the various farm crops need for optimum growth, and what effects too much and too little water had upon the growth and chemical composition of plants.

In the San Joaquin Valley, California, it has been found that 15 to 20 inches of water for heavy soils, and 20 to 25 inches on lighter soils, distributed over 3 or 4 irrigations, was about the right dosage for cotton, provided sufficient water had been applied before seeding to wet the soil to a depth of 5 or 6 feet. The shedding of cotton bolls was rather serious when considerably less water was applied. In the central coast regions of California in seasons of normal rainfall, it has been found that pear and apple orchards get along nicely till late in the season, when 1 or 2 light irrigations may be needed. Investigations in the Coachella Valley, California, indicate that date trees take about 6 feet of water out of the soil annually. This requires about 7½ feet of applied water, if exceptionally heavy cover crops are used in the orchard. Grapefruit seemed to need 5 to 7 feet of water annually, and grapes 4½ feet, these results being observed in one of the driest, hottest sections of California.

During irrigation studies in the Gallatin Valley, Montana, it was learned that irrigation has a cooling effect on the soil extending to a depth of at least 16 inches, diminishing from day to day but being measurable for nearly a month after irrigation. When peas were irrigated before bloom the amount of phosphorus and nitrogen in them was increased. When irrigation was deferred till the peas were in bloom the largest yields were obtained.

IRRIGATING BEANS IN COLORADO

The Idaho Station in a 7-year study of alkali troubles in that State, discovered that impervious soils and subsoils hindered or prevented good drainage and thus caused slow or uncertain reclamation of land from alkali. For flooding the land to remove the excess alkali it was found possible to use moderately alkaline irrigation water. The best results in removing the alkali were had from frequent flooding, with free surface run-off. For slowing down capillary action which carries more alkali from below to the surface beneficial effects were observed from using a ground covering such as barnyard ma-

nure or straw in starting the first crop. Alfalfa may be irrigated by the flooding method, which is applicable on fields too steep for other methods, or by the border method, in which the field is divided into long, narrow strips separated by low levees, extending in the direction of the steepest slope.

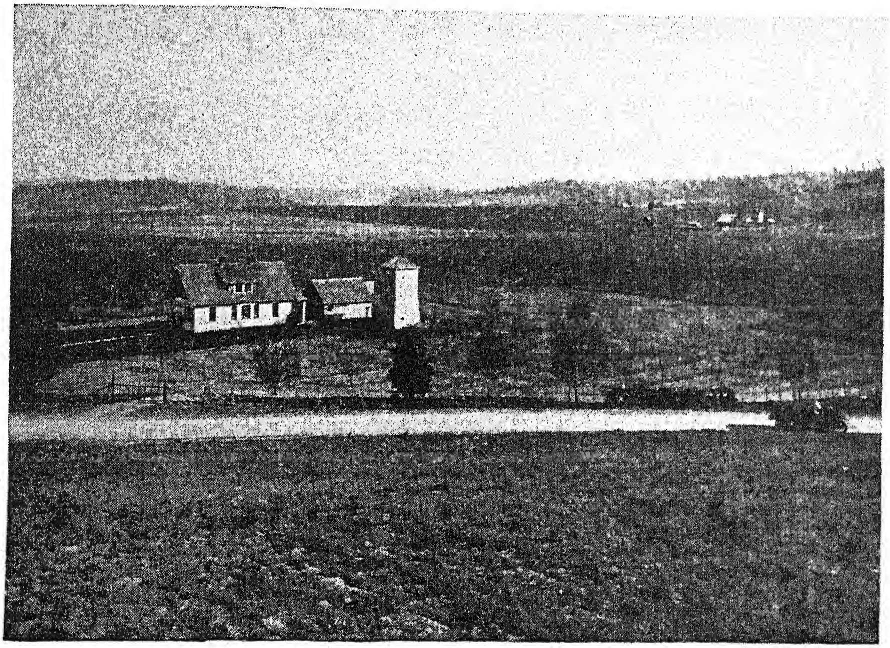
With alfalfa it appears that "for the first few months in Montana the energies of the plant are devoted mostly to the establishment of the root system. The least demands for water occur in the spring. From then on the demand for water increases slightly up to the blossom stage."

For small grains flooding is probably the most used method of irrigation. "The best rate of seeding depends upon the available supply of water. If water is at hand the land may be heavily seeded, but if water is scarce the seeding should be lighter, about 1 bushel of wheat to the acre when only a moderate water supply is used," according to experiments in Utah. The total annual application of water to grain crops varies from 1 to 4 feet applied in 3 irrigations.

In estimating the probable velocity of the water in a proposed ditch with a known fall, it should be remembered that with the same fall the velocity of water in a ditch 10 feet wide is 4 or 5 times as great as in a ditch 1 foot wide.

The original cost of the main ditch and the laterals will vary enormously, according to the local conditions, such as character of the soil, slope of the country and required length of the ditch. Where the fall of the natural stream from which water is to be taken is slight, the expense of getting water on adjoining land may be greater than the value of the land will warrant. With the present land values, irrigation by gravity is impracticable along such rivers as the Missouri.

In arid regions where rainfall cannot be relied upon during the growing season it has been experimentally demonstrated that for bringing field crops to maturity a volume of water sufficient to cover the area to a depth of 2 or 3 feet is required. Several units of measure for water are in use. The miners' inch is the volume which in a period of 24 hours will pass through an opening 1 inch square under a pressure of 6 inches. The difficulties of accurately measuring water by this standard are great, and it has been generally condemned by irrigation experts. It is



COLVILLE VALLEY, WASHINGTON

still in use, however, in a number of States. The cubic foot per second unit for measuring water is simple and reliable. It is an easy calculation to compute the volume of water from the size of the aperture and the velocity of the water. Another unit in general use is the acre foot, or the amount of water necessary to cover 1 acre to a depth of 1 foot, viz., 43,560 cubic feet.

In general, irrigation is necessary for successful farming throughout the country west of the 100th meridian. Stock raising is the chief agricultural industry under a system of irrigation, and probably will remain so. In some regions grains are the chief irrigated crops, in others roots, in still others small fruits and orchards. Any field, orchard, or garden crop may be raised by irrigation. There are many valleys in the Western States where, even with a rainfall of 5 inches for the growing season, irrigation is not absolutely necessary, and fine crops of cereals are raised in foothills where it is impossible to get water. But where water is to be had, better crops are raised by using it.

Naturally some soils are more susceptible to the dangers of washing than others. On land which is easily eroded and washed away the ditches should be surveyed in such a manner as to prevent excessive washing. In loose, deep soils overirrigation sometimes leads to the formation of subterranean channels and caving in of the overlying soil.

The time to irrigate is learned by experience in each locality, for local conditions vary greatly. In general, however, a change in the color of crops indicates their need of water. An examination of the soil reveals at once whether or not it is becoming too dry for plant growth. As the supply of moisture in the soil begins to be exhausted the plants turn a darker green than the normal color, the lower leaves turn yellowish and some of the leaves may droop and curl. When these signs are observed water should be applied at once so as to prevent permanent stunting of the crop. Overirrigated crops develop a sickly yellowish-green color. Where water is plentiful the mistake of using too much is perhaps more frequent than that of not using enough. Inexperienced irrigators sometimes seem to think that irrigation consists simply in having plenty of water and turning it upon the crops, but the necessity of giving close attention to local conditions in successful irrigation is being gradually realized.

In areas of field crops which are planted in rows and in orchards and small fruit plats, cultivation of the soil should follow as soon as possible after irrigation, in order to conserve the supply of moisture and prevent caking of the superficial layer of soil. Some soils bake on the surface after irrigation. In such soils irrigation may precede the planting of the crop, if the ground would otherwise be too dry for the germination of the seed. When water is applied soon after sowing time for the purpose of making seed germinate, the ground may be baked so hard at the surface on drying that the grain is unable to stool.

In some localities the area of land upon which water may be taken in ditches is not sufficient to exhaust the available supply of water. On the other hand, there are many regions where the water supply in summer is limited. Here it has been found advisable to soak the ground thoroughly in winter when the water supply is plentiful. It has been demonstrated that the soil may thus be saturated to a depth of from 20 to 30 feet. Since it is well known that the roots of orchard trees and of alfalfa may penetrate 15 or 20 feet into the soil, it is apparent that such plants may obtain moisture without the superficial application of water in summer.

Irrigation on a large scale is made possible in Western States by the regular gradual slope of the land. In Eastern States these conditions are generally not present and irrigation is of restricted application.

LEGUMINOUS PLANTS (*Leguminosae*)

An important family of plants, comprising over 7000 species of trees, shrubs and herbs. To this group belong such farm crops as clover, peas, beans, alfalfa, vetch, melilotus, cowpeas, soy beans, lupines, etc. These crops are especially rich in protein, one of the most important constituents of all feeding stuffs, since it contains the element nitrogen, which furnishes materials for the production of lean meat, muscles, nerves, skin, blood, tendons, wool, hair, casein of milk, albumen of eggs, etc. This makes the legumes especially valuable for feeding to farm animals, in connection with such fat producing foods as corn, corn fodder, sorghum, grasses, many cereal grains, etc., to make a "balanced" ration.

In addition to this peculiar feeding value of the legumes they possess an-

other characteristic which makes them of the highest value to agriculture. This is the power to utilize in their growth the free nitrogen of the air. It is claimed by some writers that this power belongs to all plants. This may be true, but the legumes possess it in a preeminent degree and are the only plants in which the free nitrogen of the air is utilized in sufficient quantity to be of agricultural importance. The element nitrogen is absolutely essential to the growth of all plants. It is the most expensive element in all fertilizers. If the roots of almost any luxuriantly growing legume be examined, numerous gall-like swellings or tubercles, varying in size from the head of a pin to a pea or larger, will be found. These tubercles are not normal products of the plant, but are formed under the influence of micro-organisms. Through the agency of the micro-organisms living in these tubercles the nitrogen of the air is made available for the use of the plant. No one knows just how, but only plants with tubercles are able to assimilate nitrogen from the air, and the amount of nitrogen fixation by any plant has been found roughly proportional to the development of tubercles —the greater the number or size of the tubercles, the greater the amount of nitrogen made available to the plant.

The organisms causing the tubercles have been extensively studied. They are a form of bacteria and have been given the name of *Bacillus radicicola*. They are found in nearly all soils, but are especially abundant wherever legumes have been grown. It now seems probable that there are special forms of bacteria peculiar to each of the different leguminous plants, though the bacteria especially associated with the development of tubercles of one legume may in time accommodate themselves to others. It is a matter of practical importance, therefore, to furnish each soil with a good supply of the bacteria best suited to the growth of the legume it is proposed to cultivate.

One way of inoculating the seed is by soaking them in water in which soil from an old field where the legume has been successfully grown has been stirred. Beans were effectually inoculated by drilling in with the beans soil in which soy beans had been previously grown. When the inoculated soil was scattered broadcast over the field no tubercles whatever developed on the bean roots. This plan of broadcasting infected soil, though sometimes advised, does not usually give satisfactory results. The soil should be drilled in with the seed. Generally it has not been found necessary to inoculate soils in which the legume has once been grown, and fields once inoculated, either naturally or artificially, remain so for years.

The United States Department of Agriculture has announced a new method of growing pure cultures of the bacteria associated with the growth of tubercles on the different legumes. By growing the bacteria in a medium very poorly supplied with nitrogen it has been found possible to increase the nitrogen accumulating efficiency of the bacteria 5 to 10 times beyond normal. A way has also been found by which these pure cultures of bacteria can be sent out to farmers in dry packages like yeast cakes. These cakes, when dissolved again in water supplied with certain nutrients, multiply very rapidly and to such an extent that a large amount of seed can be inoculated with a comparatively small amount of dry material.

It must be remembered in this connection that not much benefit, if any, will result from inoculating soil in which the tubercles already develop abundantly on the legume which it is proposed to grow. When, however, tubercles do not develop the seed or the soil should be inoculated. The crop will grow larger and the soil be made richer in nitrogen as a result.

The amount of nitrogen produced in the plant and roots of an acre of hairy vetch at the Alabama Station was 105.5 pounds, crimson clover 143.7 pounds, and rye 26 pounds. The latter is a non-leguminous plant. These figures may be taken as fairly representative of the difference in production of nitrogen of leguminous and non-leguminous plants, and the much greater value of the legume for the purpose of green manuring.

Since leguminous crops are capable of utilizing the free nitrogen of the air, this fact becomes of importance in applying fertilizers to such crops. It has been found by repeated experiments that these crops respond promptly to applications of phosphoric acid and potash on inoculated soils, while the addition of nitrogen in any form is usually without benefit, or only very slight benefit, and is invariably done at a loss. When the right kind of bacteria for the production of root tubercles is not in the soil then no tubercles develop, and the legumes are like other plants and require nitrogenous fertilizers for their growth. Another fact has been noticed: If nitrogenous manures are added to soils already supplied with the

necessary bacteria, not as many tubercles develop as would otherwise be the case. These facts show that while the legumes require nitrogen, they will take it in the form in which it is most readily obtainable. However, on inoculated soils, practically as heavy crops are grown without the addition of nitrogeneous manures as with it. (*See Green Manuring* and *Rotation of Crops.*)

MULCH

This is a term applied to material spread on the ground to prevent the evaporation of soil moisture or for the winter protection of plants. The materials used are dust, straw, leaves, barnyard manure, grass and litter of various sorts. The dust mulch, formed by thorough cultivation of the surface soil 2 to 4 inches deep, is one of the best mulches for preserving soil moisture to the use of growing crops. It is based on the theory that moisture in the soil rises by capillary attraction to the surface and escapes by evaporation unless prevented. It has been found by repeated experiments that a layer of dry dust, such as is formed by cultivation, breaks up the upper end of the tubes and to a great extent prevents evaporation. When the ground becomes packed, as after rains or from long standing without cultivation, the capillary tubes extend to the surface and evaporation becomes very rapid. It is a part of good farming to cultivate lightly after every rain to break the surface crust that forms, and about every 10 days thereafter. The statement frequently heard that tillage is irrigation is based on this principle of preserving moisture by the aid of dust mulch. The practice of frequent shallow cultivation often results in normal crops, where by neglect of it they are lost by drouth. In the East cultivation 3 inches deep produces a satisfactory mulch, but in some of the arid regions of the West cultivation 4 to 6 inches deep is necessary to preserve soil moisture. The dust mulch is considered one of the most essential features of modern agriculture.

In Nebraska Prof. Emmerson made an investigation of the value of a 4-inch straw mulch in the culture of a large number of vegetables. It frequently happens on the farm that the garden is made each spring with enthusiasm, cultivated once or twice and then as the press of summer work comes on, entirely neglected. Prof. Emmerson wanted to see if a good straw mulch applied at the end of the second or third cultivation would not give better results than the usual neglect. As a result of this work he found that mulches are most useful in comparatively dry seasons. Early vegetables that require but 2 or 3 cultivations can be more cheaply grown by cultivation than by mulching. Mulches applied early in the spring before the ground warmed up retarded the growth of the vegetables. Vegetables that normally require cultivation throughout the growing season were more cheaply grown by mulching than by cultivation. For most vegetables the mulch should be used to supplement cultivation rather than to displace it.

Specifically the experiments indicated that it is unwise to mulch drilled onions, lettuce or sweet corn. In the first and second cases the stand of plants was usually injured by mulching, and with sweet corn the yields were about the same by both methods of culture, while in wet years mulching decreased the yield decidedly. With transplanted onions and with beets, salsify, carrots, parsnips, peas and melons the results were about the same by either method of culture. Very favorable results were secured in mulching cabbage, tomatoes, beans, cucumbers, potatoes and sweet potatoes. With each of these crops the yields were increased quite decidedly by mulching and the labor required was lessened. Mulched cabbage was also less injured by rot, and the same was true of tomatoes. Mulched cucumbers produced perfect fruits during dry periods when the fruits from cultivated plants were small and imperfect. The quality of potatoes was not injured by mulching except in wet places.

Winter mulches of leaves, manure, straw, muck, etc., are of special importance for protecting flowers in herbaceous borders, whether tender or not, and often for small fruits.

SOIL

Soil is decomposed rock, mixed with vegetable and animal matter. It is composed of many different minerals mixed in varying proportions. The amount of organic matter in the soil also varies. These different combinations of mineral and organic matter result in different kinds of soil; thus we have sandy soils, clay soils, loam soils, muck soils, etc. It is not the purpose of this article to discuss the origin of soils. Books have been written on this subject. I shall note briefly only the characteristics of the more

usual soils as they now exist, giving suggestions as to management.

Sandy Soils. By this term is meant soils made up mostly of sand. Such soils are often called light soils, since they are easy to cultivate. A cubic foot of sand, however, actually weighs more than a cubic foot of clay. Pure sand is composed of fine particles of quartz and has no agricultural value whatever. It will not hold water, is nonadhesive and shifting in its nature. Experiments have shown that a fine sand saturated with water and drained retains but about 7 per cent of the amount applied, a clay soil 35 per cent and a forest soil containing humus 42 per cent. Not only is a sandy soil less capable of retaining water than clay or humus soils, but it evaporates water much more rapidly than either. Its power to absorb water from a moist atmosphere is practically nil. Experiments have shown that a dry, sandy soil in one night absorbed nothing. Loam, on the other hand, absorbed 3.5 per cent, heavy clay 4.1 per cent and garden mold 5.2 per cent of moisture.

Fertilizers applied to sandy soils readily leach through and are lost. On clay or humus soils practically all the ingredients of the fertilizers applied are retained. The capillary power of sand, that is, the power that sand has to draw water up from below, as a wick draws up oil, is less than in clay, loam or humus; hence in times of drouth plants suffer more on sandy land than on heavier soils.

The problem in the improvement of sandy soils, therefore, consists largely in changing their physical condition so that they will retain plant food and moisture. The more clay and humus that can be added to them the greater will become their powers in these respects. Application of quicklime also has a binding effect on sands, making them more compact. The humus content of sandy soils may be increased by growing and turning under green manure crops and by the use of barnyard manures. On very poor soils such good forage crops as rye, buckwheat and mustard may first be grown and plowed under, lime being used at the same time. It should be the aim to commence growing the more valuable legumes as soon as possible, since these enrich the soil by adding nitrogen to it obtained from the air.

Manures should not be applied to sandy soils much in advance of the time crops are planted, since they easily leach out unless the plant roots are present to take up the food as soon as it becomes available. For this reason it is not advisable to apply manures to sandy land in the fall unless a winter cover crop is grown. Nor should sandy lands be fall plowed and left over winter without a cover crop. In wet seasons barnyard manure is very effective on sandy soil, but in dry seasons it may be, especially if very coarse, actually harmful. Half-rotted manure rather than fresh, coarse manure is most desirable for sandy lands. The rotation best suited for sandy soils are discussed under *Rotation of Crops.*

Some of the advantages of sandy soils are that they are warm, and therefore best suited for the production of early crops; they are easy to work and may be worked whenever it is not raining.

Clay Soils are retentive of moisture. If worked when too wet they bake, becoming hard and lumpy and difficult to mellow down. They are called cold soils. They are made up of much finer particles than sandy soils and have the power of retaining practically all the fertilizers applied to them. They generally require draining. Often they are so compact as to be extremely difficult to work. In wet weather they are too sticky to work, and after periods of drouth they are frequently so hard that it is difficult to keep a plow in them, and they turn up lumpy.

In the improvement of clay soils drainage, either natural or artificial, is one of the first essentials. (*See Drainage.*) Lime which has a binding effect upon sand, has a loosening effect on clay, and its use tends to make clay soil more mellow and friable and reduces its tendency to puddle. Even a small amount of lime has a marked effect. The addition of humus to clay makes it more open and porous, and hence easier to work and more productive of crops. To this end coarse manures may be applied and green crops turned under. Since clay soils are generally cold and compact, coarse manures do not rot rapidly in them, and they should therefore be applied considerably in advance of the time when they are needed by growing crops. Barnyard manure applied to clay land in the fall will lose but little of its value over winter by leaching, and, of course, should be applied then. It is advisable when possible to fall plow clay lands, especially in the Northern States, and to leave them rough. This exposes them to the mellowing action of winter freezing and thawing, breaks down the lumps and clods and put the soil in a more friable condition for spring working.

Clay soils are usually more productive than sandy soils and bear heavier later crops. Manures applied to them are not leached out and they are generally well supplied with potash.

Loam Soils. A soil containing about equal parts clay and sand is called a loam soil. A soil containing 20 to 40 per cent clay and 60 to 80 per cent sand is known as a sandy loam. When the clay predominates it is called a clay loam. Loam soils are the most satisfactory for agricultural purposes, since they are easily worked, productive and retentive of fertilizers. One of the most suitable soils for farming, all things considered, is made up of 50 to 70 per cent of sand, 20 to 30 per cent of clay, 5 to 10 per cent of pulverized limestone and 5 to 10 per cent of humus. The method of handling loam soils is intermediate between that for clay soils and for sandy soils.

Muck Soils. This subject is discussed under *Muck*. Muck soils contain an unusual amount of vegetable matter. They require draining as a first requisite for cultivated crops and weathering for a year or so. Fresh muck soils are likely to be acid, and are therefore benefited by applications of quicklime and ashes. These soils usually contain sufficient nitrogenous matter, but are often deficient in potash and phosphoric acid. For the use of muck as a nitrogenous manure *see Muck*.

Alkali Soils. In numerous large areas throughout the Western States where the annual rainfall is scanty, accumulations of alkali have taken place at various depths in the soil and upon the surface. The most common forms of alkali are sodium chlorid, sulphate of soda or Glauber's salts, Epsom salts and carbonate of soda. These salts are all readily soluble in water and only become visible when occurring in quantities on the surface of the soil, or in the deeper lying strata in a dry condition. On the surface they may form white, glistening incrustations which may be seen for many miles. The most extensive accumulation of alkali usually occurs in alkaline lakes. Two forms of alkali are commonly mentioned, the white and the black. Both are white salts but the name "black alkali" is due to the fact that this salt decomposes vegetable humus, giving it a black color. The name "white alkali" is given to soluble salts which are composed mainly of Glauber's salts and Epsom salts; "black alkali" is a common name of carbonate of soda. The source of alkali is usually considered to be in the decomposition of certain rocks. These salts are naturally found throughout the United States in all soils, but wherever rainfall is plentiful the salts are washed away and do not occur in quantities sufficient to injure growing plants.

The effect of alkali on plants varies according to the amount which is present upon the surface of the ground and in the first foot or two beneath the surface, as well as other conditions of soil and climate. The effect of black alkali is much more serious upon plants than that of other forms. It exercises a corroding influence wherever it comes in contact with vegetable tissue, and otherwise checks the germination of the seed and development of the plant. Extended experiments with different plants in regions where alkali is abundant have shown that the resisting power of plants varies with regard to alkali. Many plants may be spoken of as intolerant toward alkali, while others are especially capable of growing in the presence of alkali, and are therefore spoken of as tolerant. The plants which are most tolerant are native species which have gradually acquired the power of growing in the presence of exceedingly alkaline soils. These include the so-called salt bushes, salt grasses and weeds of little economic importance. Some of these plants have been introduced from other countries and experimented with for the purpose of determining their possible economic value in reclaiming alkali soil. Among cultivated plants the most tolerant are alfalfa, sugar beets and sweet clover. It has been found that sugar beets may be grown in strongly alkaline soil. Where chlorids are mixed with the other alkali salts some difficulty is experienced in the crystallization of sugar during manufacturing, but for feeding purposes, sugar beets are apparently not badly affected by growing on alkaline soil. Cereals, as a rule, do not do well in the presence of alkali; rye, however, is much more tolerant than wheat or oats, and barley appears to be somewhat resistant to alkali.

Experiments have demonstrated the efficiency of a number of remedies in reclaiming alkali soils. Since the main source of alkali is in the deeper strata of the soil, it is apparent that seepage water, when coming to the surface by capillary action, must carry quantities of alkali, which are left upon the surface of the soil by the evaporation of the water. Care

should therefore be exercised to prevent seepage. Thorough cultivation of the surface of the soil will make evaporation less rapid and will prevent to some extent the accumulation of alkali at the surface, where it does most harm. Cultivating tolerant plants on alkali ground is also of advantage, especially in the case of deep rooting plants. Small quantities of the alkaline salts are taken up into the plant substance, and are thus removed when the crop is harvested. The presence of a vegetable covering to the soil prevents the superficial evaporation to a large extent, and water which is required for the growth of deep-rooting plants is taken from a considerable distance beneath the surface. Where the alkali is of the black form, or carbonate of soda, the addition of large quantities of gypsum to the soil changes the carbonate of soda into the less harmful sulphate of soda. This chemical reaction, however, naturally does not take place when the alkali is already of the white form, or sulphate of soda. The use of gypsum, therefore, in such cases is of no value. Lime has a corrective effect upon Epsom salts, and where analyses show this to be the chief alkali salt, liming of the soil is to be practiced.

The remedies thus far mentioned, however, are of a temporary nature and do not remove the alkali from the soil. Wherever plenty of non-alkaline irrigation water is to be had and drainage is possible, the sovereign remedy for alkali consists in flooding the surface abundantly with water and in under draining. By this means the alkali salts are dissolved and carried away in the drainage water. Analyses of such water already made have shown that large quantities are carried away in this manner.

The role which the soil may play in flood control is often overlooked in discussions of the problem. When soil is covered with growing vegetation, shrubs, bushes or stubble in grain fields, the run-off of surface water during the storms is impeded and hence more of it soaks into the soil. Good porous soil containing humus has an enormous capacity for holding water, later giving it up slowly by evaporation, by transpiration through growing plants, or contributing to the flow of springs or even artesian wells. The large volume of water thus held back at the source of the thousands of rivulets which go to make up the larger streams, materially reduces the flood water in such streams.

SOIL CONSERVATION

Today conservation is a word to conjure with. After three centuries of extravagance and wilful waste in which we boasted that all American resources were inexhaustible—soil, forests, iron, coal, oil, gas—we are sobering up from that orgy with the realization that these gifts of nature are not unlimited in quantity, that all of them are being needlessly squandered and that the end of some of them, at least to the eye of the geologist, is already in sight. It would be an unobservant traveler who could sail past the mouth of the Mississippi, the Columbia, the Amazon, the Ganges or the Yellow River without noticing the vast stretch of water rendered yellow or muddy brown by the particles of fertile top soil carried down to the sea by these rivers from the thousands of farms lying along their courses. R. J. Russell has estimated that the Mississippi annually carries into the Gulf of Mexico 730 million tons of soil. Some of the soil came from Montana, some from Iowa and some from Arkansas, and at least 17 other States. These States are not only made poorer by the loss of soil but the silt is deposited in the bed of the river, making it difficult to build dykes high enough to prevent the occurrence of disastrous floods. Then, too, in the delta of the river the bed becomes so clogged with mud as to render it difficult and very expensive to keep the channel open for shipping. The Yellow River, or Hwang Ho, dyes the whole Yellow Sea with the color that gives it its name. The Parana River from its source to Buenos Aires resembles a brown porridge. H. H. Bennett has estimated that 3 billion tons of soil from our farm lands and pastures are removed annually by wind and water erosion, and that this huge mass of soil contains the equivalent of 90 million tons of essential fertilizer elements, and that this sum is 50 times or more the amount of fertilizer applied to our farms annually. Careful measurements of silt in run-off water from farm areas in Missouri showed that 69 tons of soil per acre were washed off yearly under a 35 inch rainfall from clean-tilled crop, while only 600 pounds were lost from soil under a dense cover crop. At that rate it would require only 16 years to wash off 7 inches of top soil from land under clean-tillage.

In the 1860s, when a farmer could move on to another farm as soon as he had worn out his first one, these mathematical calculations would have worried him not a

whit. It is only when all good farm land has been taken up, when the farm must last a lifetime and be passed on to succeeding generations of the family, that the need for keeping the farm soil anchored in place comes home to the farmer.

Since ancient times there have been efforts to control water erosion. Some of these efforts were in vain, as evidenced by the ruined buried cities in various parts of the Near East. The terraces of the Incas, and particularly the perfect terracing of mountain land for rice in Java and the Philippines, show how effective this method of control may be when the terraces are properly made and kept in order. But engineers claim that 70 to 90 per cent of the terraces in some of the Southern States are inadequate to control water runoff, or are actually worse than nothing. But erosion from rainfall may be held in check by a combination of terracing, strip planting, control of gullies with grass, contour farming, cover crops for seasonal protection, grassed channel ways to carry away surplus water, construction of small reservoirs for holding stock water and improvement of pasture through rotation grazing. Some of these points have been considered in the various articles on legumes suitable for soil binding.

Periodically, the dust bowl of the west is the scene of the sorry destruction of crops and top soil by winds. Two and a half years of drouth are enough to try the patience of Job. Then to wake up some morning and find your farm and your neighbor's farm waltzing away with a 40 mile wind. That is merely a tame manner of hinting at the experience of a 65,000 acre tract in one of the Western States.

A great campaign was started involving the cooperation of farmers, business men and railroad officials. It took 3 years of hard work to stop the drifting of the soil. They ran lister furrows across a quarter of the land which was sliding away in the wind. They roughened the surface with any available implement of cultivation. They kept on planting crops to help hold the soil. By the fall of the third year the farms were all safely anchored again. Then Nature finished the job with the soaking rains of the next year. These same farms resumed the production of as big crops as ever. Or in many cases it was a sub-basement farm which was on the job, the original ground floor of the farm having been piled up in a railroad cut or in a pasture field in huge drifts 5 to 10 feet deep.

Scores of news items and stories were written about "a whole county blowing away" but the most important result of the big blow has been quite overlooked. It forced a better and more rational system of farming upon the wheat growers. It toppled over the dust-mulch fetish and put up in its place a shrine devoted to common sense. While the 3 years of dust and drifting soil were a horrible nightmare, it is now remembered merely as a nightmare.

Nature had already become tired of having the Great Plains soils wear themselves to powder by drifting back and forth across the country, and had securely anchored the soil by means of grass. Such wonderful soil binders were these grasses that the sod formed by the roots made excellent structural material.

Now, these same grasses with their remarkable root development furnished the overcoat which forced the winds to go on about their business without disturbing the soil. For the Great Plains is a windy country. For example, the weather records show that near Dodge City the wind on 1117 occasions during the 6 year period of 1907-1912 exceeded a velocity of 20 miles an hour. In fact, during the months of April, May and June the wind passed a speed of 20 miles an hour an average of 19 times a month and sometimes reached a velocity of 52 miles.

In the early days of settlement each homesteader plowed only a small part of his land during any one season. Most of these families came from regions where diversified farming was the established practice and brought cows and hogs with them. But wheat farming rapidly increased in popularity. The homesteaders began plowing more and more land. Just before the big blow tractors had gained great vogue. They made it possible to plow up all the land in sight. Most of the land had already been planted to wheat continuously for 20 years. It was plowed only once in 3 years, and then only from 3 to 5 inches deep. The rest of the time it was merely disked. No attempt was made to put humus back into the soil. Even the straw was burned.

And all these years a terrific barrage of dust-mulch propaganda was laid down over the Great Plains. The farmers were frantically urged to keep the disk harrow, the smoothing harrow and the plank drag going all the time. The soil surface must be kept pulverized into a fine dust. This

was the whole secret of dry farming. By this method you could keep the soil moisture from escaping and raise crops whether it rained or not. And the farmers supposed that these experts on dry farming knew what they were talking about, so they scratched and disked and harrowed the top of their farm into a sort of talcum powder. Then came the big blow and the entire topsoil to the depth of 6 inches, or as deep as it had ever been stirred with plow or harrow, blew away. Then the farmers began to wonder who had been throwing the most dust in their eyes.

Mr. G. H. Kinkel condensed his long practical experience with blow soils into a few short sentences: "You simply must break the surface if it has become smooth. Even a weighted disk harrow will do it if no better implement is handy. List all fields, even pastures. Deep plowing is only a temporary help. Plow at once after harvest, July 15 to August 15. Leave the field in the plow ridges or harrow it into furrows. Always plow, list and cultivate at right angles to the prevailing wind. A constant procession of troughs will thus catch the soil particles loosened by the wind, and prevent the movement from becoming general or continuous. Winter wheat is the best protection against soil blowing. Sometimes it may be advisable to leave the stubble standing as long as possible, but you must get the wheat started in the fall so as to cover the ground."

In western Kansas and Nebraska damage from soil blowing "most frequently occurs on summer fallow, in corn stubble fields, and other fields that have been cultivated so much that the surface is very fine and dry."

Planting crops in alternate strips across the wind has been found a quite efficient way of checking soil drift. Thus corn or sorghum may alternate with strips of grain or grass or alfalfa. This is particularly serviceable where blowing extends far into the summer, as in parts of Colorado.

One of the shining examples of wind-blown soil deposits is the Palouse country of Washington and Idaho. This whole region is just one big rounded hill after another. These wonderfully graded hills are merely heaps of soil gradually carried over by the strong west winds from Pasco, Umatilla, Walla Walla and other dry regions farther west. The hills are usually 150 to 200 feet high, the northeast slope being steepest.

Byron Hunter of Moscow, Idaho, has made an extensive study of the blowsoil problem of the Columbia and Snake River basins of Washington, Oregon and Idaho. Soil drifting in this region is a serious matter in many localities. Summer fallowing is a general practice, leaving about one-half of the crop land bare and exposed to wind action. "The best way of handling these soils," says Hunter, "consists in leaving the stubble and trash on or mixed with the surface soil, making enough clods to cover the surface of the ground and rubbing and pulverizing the soils just as little as possible. In the past blow soils have been summer-fallowed by very much the same methods as are used for light soils that do not blow. This has frequently resulted in disaster."

Plowing with mold boards removed and directly after harvest will leave the stubble and weeds on the surface and thus help to prevent soil drifting. As soon as the frost is out of the ground in the early spring, and while the soil is still wet, a clod-mulch may be made with a spring-tooth harrow. The ground by this method is stirred about 5 inches deep. If weeds start up in the spring they may be controlled with the rod-weeder, the rod passing just below the mulch. To protect winter wheat from soil blowing, Hunter recommends harrowing the wheat in the spring when the soil is wet, or if there is a light stand of wheat, cover it with manure or straw. Rye planted in the stubble in the fall and used as pasture the next spring and summer, will also help to hold the soil.

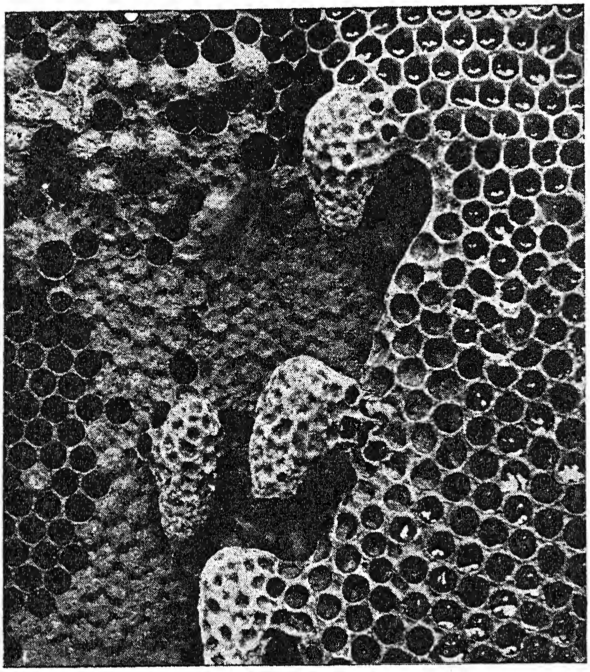
But it is not the drylanders alone who suffer from soil blowing. Dust storms and wind erosion occur over all the great stretches of semi-arid range country. Similar experiences might be related from California. Then there are areas that sometimes suffer from wind erosion in various parts of Texas, Oklahoma and North Dakota. Even on irrigation projects soil blowing may become serious. Farmers have often had cause to regret that they removed the sage brush from too much land at once. For just as they had the land nicely leveled and pulverized, and before they could irrigate, the wind blew their soil away and piled it in another place. Thus they learned the lesson of clearing only a little at a time and getting that anchored before proceeding with the removal of sage brush from more land.

Growing plants of whatever kind,

whether trees, corn, wheat or grass, serve to some extent as windbreaks. Stubble and other trash left behind in harvesting farm crops are also of some value for the same purpose. This material, including crop roots, when cultivated into the soil, and before complete decay, acts as a soil binder. Humus or decomposed vegetable matter incorporated in the structure of the soil is commonly supposed to be useful in the same direction, for the reason that it increases the water holding power of the soil and tends to flocculate the soil into coarser granules. These evidences of the serious loss of good fertile top soil by wind and water serve to remind us that in nature soils are held in place by plant roots. Grasses, legumes, trees and weeds serve this purpose. When the top soil is gone it may require a lifetime to transform a raw, inert subsoil into a suitable seed bed for cultivated plants. The moral of the story, therefore, is obvious. Keep your soil tacked firmly to the subsoil by means of plant roots, and maintain a surface cover of vegetation for as great a part of the year as is consistent with the raising of cultivated plants.

PART VIII

MISCELLANEOUS



WHEN THE BEES WANT A NEW QUEEN, LARGE CELLS LIKE PEANUTS ARE BUILT FOR NURSERIES

MISCELLANEOUS

AGRICULTURAL COLLEGES

Each State maintains a college, supported by State and federal appropriations, devoted primarily to instruction and research in all phases of agriculture, mechanical arts and domestic science. These colleges are directly and intimately connected with the State Experiment Stations, and in several States are considered as part of the State University in the general system of state-wide education. Many of them have been in operation since the early 1850's, have acquired generous building space, scientific equipment, teaching staff running up into the hundreds, and some of them are attended by 6000 to 10,000 students. Courses of study are arranged in various lengths from 2-week winter terms on a particular subject, to 2 or 4 year regular organized curricula leading to college degrees, and post-graduate courses are offered for research students.

The subjects taught at these institutions include not only agronomy, animal industry, economics, entomology, plant pathology, soils, veterinary science, botany, bacteriology, chemistry and genetics but also English, foreign languages, music, meterology, engineering, geology, psychology, history, anatomy, and numerous other matters, as in colleges of liberal arts.

In addition to resident instruction and research, the agricultural college carries on a state-wide system of agricultural and general education by correspondence, radio, farmers' institutes, reading courses, farm-home week, farm bureau meetings and regular sessions of local agricultural associations at which groups of the college and experiment staffs attend. The prescribed reading courses lead to more or less formal examinations and the issuance of certificates to those who have successfully passed. Reading courses are not confined to the farming population but are open to all citizens. The courses in domestic science, at first concerned only with the practical phases of cookery and household affairs, have extended into elaborate studies of nutrition, canning, preserving, dying, fabrics and nursing. In bringing into practice the discoveries made in the conduct of this research, the county agricultural agent is the most vital factor since he visits most of the farmers in his county and acquaints them with new methods and ideas which may be locally utilized to advantage.

AGRICULTURAL EXPERIMENT STATIONS

These are State institutions organized for the purpose of conducting agricultural experimental investigations. The first regularly organized experiment station in this country was established at Middletown, Conn., in 1875. Other stations were established soon after in a number of widely separated States, and in 1887 Congress passed a bill, popularly known as the "Hatch Act," appropriating $15,000 annually to each State and Territory for the maintenance of an agricultural experiment station. Since that date stations have been established in every State and Territory, including Alaska, Hawaii and Porto Rico. With but few exceptions, provided for in the Act, the stations must be departments of the land-grant agricultural colleges (*see Agricultural Schools and Colleges*), and their officers are often professors in the college.

Other federal appropriations have been granted for Experiment Station support, and the State Legislatures make annual or biennial appropriations often of very generous proportions. Large sums are also received from private or corporate sources. The Experiment Stations have thus become richly endowed research institutions.

Since their organization these stations have conducted a vast amount of research work along nearly all lines of agriculture. The results have been published in the form of popular reports, bulletins, circulars and press notices for agricultural papers, and sent free to a large mailing list of farmers, and to everyone else interested in agriculture who asks for them. In most cases these publications not only give the results of experimental work done at the station, but include as well information on the practices of our most successful farmers, horticulturists and stockmen. These publications are im-

mensly practical. The experiment stations are becoming more and more popular each year as their purpose and methods of work become known. The most progressive farmers keep in constant touch with them and find them a great help. The work of each station is usually that in which the State as a whole, is most interested.

Notwithstanding the value of these publications and the fact that they are mailed free for the asking, many farmers of the country do not avail themselves of them. This arises in many instances from a lack of information concerning them and a knowledge of where to write for them.

Not only do the stations send out published information but they give much personal advice in response to letters sent in. This constitutes an important part of the work done, and farmers may feel free to ask the station for any information, at any time, along agricultural lines, and may be reasonably sure of getting a satisfactory reply. Your County Agricultural Agent usually has information about these bulletins and is glad to help you obtain them.

ANTS

A number of species of these insects occur in houses, the more important of which are the little red ant, little black ant and pavement ant. None of these are very destructive to household supplies, but become a nuisance on account of getting into sweet food materials. As soon as a discovery of this sort is made by an ant the whole colony seems to learn of it within a short time and the house may become infested with a large number of ants. As is well known, the colonies of ants contain individuals of different sorts and usually comprise a large number of individuals. Where the nests can be found in lawns or near houses, the ants may be destroyed by pouring boiling water into the nests or saturating them with kerosene, or by making small holes in the nest with a stick, pouring an ounce or two of bisulphid of carbon into each hole and quickly closing the holes. When the nests cannot be found, an efficient method for catching ants in houses consists in placing small sponges moistened with sweetened water where they will be found by ants, and immersing these sponges at intervals in hot water to destroy the ants.

Thorough cultivation of the soil has been found efficacious in destroying ants in some localities. Some species of ants are slightly beneficial from their habits of attacking cotton worms and other injurious insects. When ants are seen running up and down fruit trees and other plants, an examination will usually disclose the presence of plant lice on such plants. As is well known, most plant lice are attended and cared for by ants, and the presence of ants on cultivated plants may thus serve as an indication of infestation of plant lice. Under such circumstances the ants do no harm to the plant except in the way of assisting in the distribution of the plant lice.

BEES

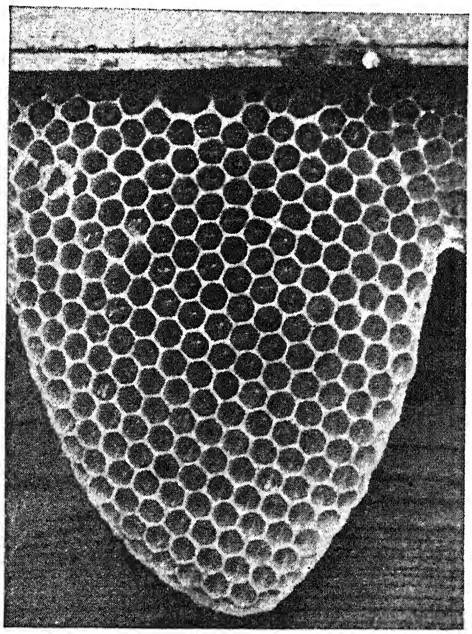
Beekeeping is a sufficiently important farm industry in every one of our 48 States to be prominent in agricultural statistics. There are about 4½ million colonies of bees in the U.S. with an annual production of 136 million pounds of honey. The leading honey States are California, Michigan, Ohio, Wisconsin, Illinois, Iowa, New York, Texas and Minnesota. These figures cover commercial production, but by far the greater number of persons engaged in the business have only a few swarms and raise honey for home consumption. Thus 56 per cent of the beekeepers of New Jersey have only from 1 to 5 colonies, while only 1 per cent have 100 or more hives.

In many parts of the country extensive apiaries have been established and managed on a commercial scale, for the purpose of furnishing honey for market. Keeping a few bees in connection with other agricultural pursuits furnishes an agreeable occupation for people who are interested in such work and furnishes a delicacy for table use which is universally held in high esteem.

Aside from the production of honey, which constitutes the main reason in a majority of cases for keeping bees, these insects are of great economic importance in connection with fruit raising. The relationship of insects to the pollination of fruits has been much discussed in scientific journals and in agricultural papers, but the necessity of their assistance in order to secure a full crop of fruit, whether of orchard or berry kind, is perhaps not fully appreciated. Experiments have shown that most fruit trees and bushes are either partially or only slightly pollenized when bees and other insects are prevented from visiting the flowers. Many varieties of fruit trees are self-sterile and require that pollen be carried from other trees or other varieties in order that a good crop

of well-formed fruit may be produced. Bees are the most useful of all insects in the fertilization of fruits. The labor incident to maintaining a few colonies about the home is amply repaid in the increased setting of fruit, without considering the value of the honey produced.

Commercial fruit growers maintain large apiaries in their extensive orchards primarily for the purpose of increasing the set of fruit, or rent colonies for the blooming season from professional beekeepers.



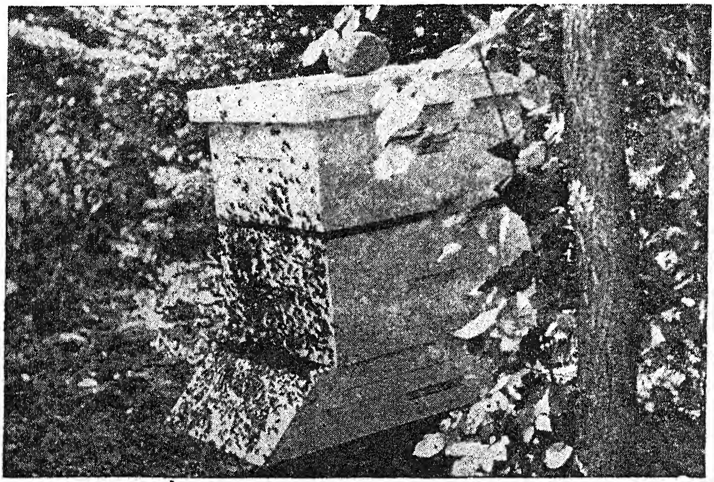
NEWLY STARTED HONEYCOMB

Bees may be successfully kept in any locality where agriculture or horticulture can be pursued with profit. In fact bees maintain themselves in a wild state in many situations where agriculture is as yet impossible on account of the lack of cleared and arable land. Besides ordinary agricultural regions in country districts, bees may be kept in cities, especially favorable situations being found on the house roofs. From such locations they can easily reach garden plants, sweet clover, white clover and other honey-producing plants.

Bee Plants. It has often been supposed that in order to keep bees profitably, or even successfully, it is necessary to plant special crops for the purpose of producing honey. Experiments along this line have shown that the cultivation of special honey plants is neither profitable nor desirable. In all agricultural and horticultural regions a sufficient number of honey-producing plants are cultivated for other purposes, and bees, besides assisting in fertilizing such plants, can obtain enough honey for their own use during winter, and also a considerable quantity which may be removed for consumption in the family. Among the more valuable bee plants mention may be made of clover, white, alsike, crimson, and the 2 species of sweet clover, fruit blossoms of all varieties, alfalfa, willow, esparcet, linden or basswood, rape, buckwheat, chestnut, cotton and locust trees. Besides these cultivated plants and shade trees, a very large number of wild herbs and trees are visited by bees for the purpose of obtaining honey or pollen. In the South the red-bud, alder, soft maple, June-berry, orange, black gum tree, white sage, sourwood, and saw palmetto are important honey-producing plants. In the Northeastern part of the country willows, wild crabapple, yellow locust, tulip tree, linden, knot-weed, buckwheat, grape, willow herb, goldenrods furnish large quantities of bee food. In the Middle and Western States a number of the trees and other

plants already mentioned serve as a source of honey, but special mention should also be made of white sage, Rocky Mountain bee plant and buck-brush or waxberry. Bees readily adapt themselves to the flora of the particular locality in which they are raised, and quickly choose the plants which furnish most pollen and honey for their use.

Replies to a questionnaire sent to bee-keepers by the Department of Agriculture gave alfalfa first rank as bee plant in Idaho, Nevada, Oregon and Utah, and second place in 10 other States. Alsike clover stood at the head in 7 States, sweet clover in 14, white clover in 11. But this article cannot give space to consider the hundreds of plants known to be of first or second rank as sources of honey. Dandelion is not mentioned as often as it should be in this connection, but is a very good early spring source of both nectar and pollen. Among other prolific sources of pollen are fruit trees, corn, maples, yellow sweet clover, etc.



WHEN THE SWARM LEAVES THE HIVE

Varieties of Bees. A few experiments have been made in introducing the giant East India honey bee (*Apis dorsata*) into this country, but the experiments have not been carried far enough to permit definite conclusions as to the value of this species. The common honey bee (*Apis mellifica*) is represented in this country by several varieties or races, Cyprians, Italians, Carniolans, and German bees. The common brown, or German bee, was the first variety imported into this country and is distributed from the Atlantic to the Pacific. The Cyprians are good honey collectors and work persistently when the honey secretion becomes scanty. They are easily kept through the winter and defend their hives with great energy. On account of filling the cells completely before capping the honey has a transparent appearance which interferes with its successful marketing, and the bees are easily aroused and led to attack attendants. Italians cap the honey so that the comb appears white, and much less skill is required in subduing and handling them. The domestic Italians are far gentler than the Cyprians. The Carniolans are of a gray color and are perhaps the gentlest of all races. Since they have shown their good qualities in resisting the climatic changes of winter and in gathering large stores of honey under adverse circumstances, they are gradually becoming more and more popular.

In an average locality for honey collection, a vigorous colony should produce about 20 pounds of comb honey, besides what is required for winter keeping of the bees. This amount will be considerably increased when colonies are favorably located near large areas of 2 or more of the most important honey plants. Large stores of honey should not be expected in all seasons, and the amount which is gathered by bees varies greatly from season to season, depending on drouths, earliness or lateness of the season, and

other less thoroughly understood conditions, which determine the honey flow.

The management of bees may be readily learned by anyone who desires to manipulate them. The Carniolans are perhaps the best choice for amateurs, since, as already indicated, they are the gentlest race. After some experience with bees other races may be preferred in certain localities, according to experience in each locality.

Hives. The Standard hive is most generally adopted. This hive is not patented and may be obtained from all manufacturers of bee supplies. These hives are cheap and it is perhaps best to buy them of regular dealers, since the proportions will be more accurate and the fitting of parts is more perfect than would be the case in homemade apparatus. Where it is desired to obtain comb honey, hives should be used which permit insertion into the brood apartment of a number of frames, up to 10. The Standard hive readily admits of expansion and contraction, as occasion requires. It should be covered with a tight-fitting, rain-proof roof in winter. A number of hives may be surrounded with a frame structure, leaving a few inches of space between the hives and the outside structure, which may be filled with straw, excelsior, or other substances. All beekeepers should be provided with one or more bee smokers, which are sold at moderate prices by all manufacturers of bee supplies. Smoke is almost universally used for the purpose of quelling or stupefying bees, when it is necessary to open the hive for the purpose of removing honey or for inspection. The beginner will find it desirable to use a veil to protect the face and gloves for the protection of the hands. Old and experienced apiarists often find these accessories unnecessary.

Swarming. Ordinarily when a colony of bees puts forth a swarm the bees fly about for a short time and gather in a clump on a tree, bush or other convenient object near the apiary. The process of transferring the swarm to a new hive will be determined largely by the circumstances of each case. When the swarm collects upon a small branch of a tree, the branch may be removed gently and the whole mass of bees carried and deposited in a hive, or they may be shaken off into a hive by one vigorous blow. If the practice of clipping the queen's wings is followed, the queen will of course fall to the ground as soon as the swarm issues, and may be secured in a cage. The bees, after flying about for a short time, return. If in the meantime an empty hive is placed in the position where the parent colony previously was, the bees will enter the new hive and the queen may be allowed to go in with them.

It is frequently desirable to prevent swarming entirely or to prevent the issuance of more than one swarm during the season. It is evident that the more energy the bees give to the production of young bees, the less extensive will be the honey production. One of the most commonly practiced preventive measures is to give abundant room for the storage of honey. This should be arranged for early in the season. Free ventilation should be accorded the bees, and when hot weather appears, the hives may be shaded, in order to prevent the development of a too high temperature inside the hives. Hives may be opened once or twice weekly and all the queen cells destroyed. Queen traps have been so constructed that the queen on returning to the hive is captured. The use of such traps and clipping the wings have been generally recommended by the stations.

Wintering Bees. Wintering bees in greenhouses is not to be recommended. It appears that bees are useless for pollinating fruits in winter and are not content with the limited quarters, but spend a great portion of the time trying to escape from the houses. When bees are moved into cellars the apartments should not be damp and the temperature should be maintained between 44° and 48° F. If the temperature of the cellar is allowed to rise too high, the bees become active, a much greater loss of bees occurs, together with a much greater consumption of store. In the South bees are wintered on summer stands in the open air. This method is also successful in the North, with proper precautions, but usually they are placed in cellars, or a secondary box-like structure is built around them for further protection. When the winter season is entered upon it is essential that the colony should have a good queen, an average sized cluster of healthy bees, and a sufficient quantity of food. In the South from 15 to 20 pounds is considered sufficient for outdoor wintering, while a similar quantity is sufficient for wintering in cellars in the North and from 40 to 45 pounds for outside wintering. In outdoor wintering, cold and dampness are the great obstacles to be overcome. A good cluster of bees can resist a very low tem-

perature if thoroughly dry. The chief problem of wintering is to retain the warmth generated by the bees and at the same time prevent a too great accumulation of moisture in the hives. In cold climates colonies may be packed with dry chaff or similar substance in such a way that the moisture is absorbed without allowing a free draft through the hive.

Apiaries should be situated so that there are no serious obstacles near at hand to interfere with the flight of the bees to and from the hives. A place may be easily selected which is not needed for other purposes and will not interfere with other agricultural operations. In some localities it may be well to choose a protected side of a building, where the colony will not feel the force of the wind in winter and where they may be sheltered from the direct rays of the sun during the hottest part of the summer.

Feeding Bees. In many cases it will be found desirable to feed bees during the winter season for the purpose of bringing the colony out in the spring in a more vigorous condition. In some experiments, where extracted honey was fed back after the honey season was over, it was found that this was done with a profit of nearly 6 per cent. Other experiments along the same line have been unsatisfactory, and in some parts of the country stimulative spring feeding is positively injurious. In feeding sugar syrup to bees, it is perhaps the best practice to feed a considerable quantity rapidly. Sugar syrup is probably a more economical food for bees than honey.

Where comb-honey is being produced for the market, a great amount of work is put upon the bees in the manufacture of necessary wax. Wax is made out of honey and from materials which are collected by the bees, and a large number of bees is necessarily kept from doing the regular work of collecting while engaged in the manufacture of wax. It has been found advisable, therefore, to furnish wax in some form to bees for their use in building comb. Wax thus furnished is usually in the form of a foundation, with or without cell walls. The bees use the wax in the artificial foundation to extend the cell walls and comb midrib. If the heavy foundations are used, they are somewhat thinned out by the bees in constructing comb upon them, but such foundations are not thinned in any case to the lightness of natural comb. The cell walls in a natural worker comb are thinner than the walls built upon artificial foundations, with the exception of those which are constructed upon extra thin superfoundations. It is a mistake to use artificial foundations with artificial deep cells, unless their walls can be rendered as thin as those of the natural cell walls. Heavy foundations result in combs which are heavier than the natural combs, and the increased weight is due both to thickened midribs and thickened cell walls, but more especially to the latter. The natural wax secretion of bees is not lessened any more by furnishing them with heavy foundations than by the use of light foundations. In order to secure the most regular sections of honey, firmly attached all around the section, it is well to use a long, narrow strip of foundation as a starter, placed across the top of the section, or a rectangular starter extending about half way down the section. By using a long piece of foundation as a starter, gradually tapering to a point, with the broad base attached to the upper edge of the section, bees have a tendency to form worker comb throughout. It is advisable to use wooden or tin separators between the rows of sections, since the presence of these structures renders the sections more regular and tends to prevent the attachment of one section to another and the consequent breakage of the cells by separating the sections.

A number of substitutes for pollen have been experimented with, these substitutes being placed on flat boards in the vicinity of the apiary. The order of preference by the bees, so far as observations have been made is as follows: Ground whole kernels of oats, corn, wheat, fine wheat bran.

Bees kept the year round in one locality are, of course, restricted in their honey gathering to the flora of that locality. This may mean that there are considerable periods when nectar sources are hard to find. For this reason beekeepers have adopted the plan of moving their colonies from one locality to another during the season. After the fruit blooms are past and locust flowers fallen, bees might be moved into an area of tulip, poplar or linden or alsike clover, or later into large plantings of buckwheat. The active honey season is thereby greatly extended.

Diseases. Among the diseases of bees, mention should be made of DIARRHEA, which is often brought about during the winter season. It is probably caused by sour, fermented, or thin honey. Bees located near cider mills often contract this trouble from feeding too extensively on apple pomace. Intense cold or dampness

and unfavorable climatic conditions may bring about this disease. The best remedy is warmth in the hive and proper conditions for an outside flight without liability to chill.

AMERICAN FOUL BROOD, a disease caused by *Bacillus alvei* which attacks the young bees. Death usually occurs after the young have been sealed in the cells. The dead larvae may be found in all positions in the cells. No remedy but burning is efficient. The infected bees, comb and honey should be burned in a fire hole at the side of the apiary. Most States have passed laws providing for annual inspection of apiaries and destruction of infected colonies.

EUROPEAN FOUL BROOD (*Bacillus pluton*) kills the larvae before they are sealed in but does require such drastic treatment as prescribed for American foul brood. If the colony is not strong 2 or 3 colonies may be united, the old queens destroyed and a healthy, vigorous Italian queen introduced.

BEE MOTH (*Galleria mellonella*). The bee moth eats its way through the combs, especially in the brood apartments, and is often very destructive to weak colonies. The larvae of this insect protect themselves from the bees by lining their galleries with a coating of silk. The adult moths may often be seen in the corners of the hives. They are of a dull ash color, variously streaked. When seen flying about the entrances to hives they are seeking opportunity to enter and lay their eggs. The best remedy against this insect is to keep the combs under the protection of bees. Combs should be so hung as to leave space between them in a large box where they may be subjected to fumigation with sulphur fumes. The larvae of the bee moth will thus be destroyed. So-called moth-trap attachments to hives are practically useless.

ROBBER FLIES, dragon flies, some species of ants and wasps, a few spiders, and a number of birds destroy the bees, but seldom become of economic importance.

SKUNKS are troublesome pests in that they scratch on the hives and worry the bees especially in winter. If the bees are disturbed enough to leave the hive the skunks catch and eat them.

CAT

The earliest records of antiquity contain references to the domestication of cats and the esteem in which they were held. Despite the fact, however, that they have been domesticated for such a long time, comparatively few distinct breeds have been developed. A few color types have been developed and attempts have been made to breed certain races as pets, such as the Maltese, Persian and Angora breeds, but as a rule the color patterns of cats are not constant. The failure to produce distinct pure breeds of cats is apparently due in large part to the promiscuous crossing and consequent mixture of blood. No such differences in the size and general formation of the animal have been produced by domestication as have occurred among dogs and most other domesticated animals. There is no apparent tendency toward the production of a race of cats which possess any characteristics fitting them for special use of any sort. The raising of cats is consequently carried on largely for the purpose of producing pets. Their economic relationship to agriculture is not of great importance. Healthy, vigorous cats may serve to prevent the undue multiplication of mice and rats around dwellings and farm buildings. Some cats also manifest decided tendencies toward more extensive hunting expeditions, and destroy large numbers of birds, field mice, rabbits and gophers. The effect of the destruction of these animals depends in large part upon the habits of the animals which are destroyed.

Cats are subject to distemper (*see Dog*) and to tuberculosis, anthrax and other infectious diseases which are contracted by eating the meat of animals dead of these diseases. For treatment of cat flea *see* under *Dog*.

COOPERATIVES

Cooperation among the farmers of a particular neighborhood or region, or among the growers of one product, as a system of marketing farm crops or buying supplies, is doubtless a familiar idea to almost every farmer. Organizations of a cooperative nature were in operation in Europe long before they came into vogue in the U.S. The movement has had its ups and downs. The mortality among cooperative associations has been extremely high. But there are many that have consistantly weathered all difficulties, have grown steadily and have served their members well. There are reported to be about 10,600 farm cooperative associations in the U.S. with a membership of perhaps 3,400,000, and doing an aggregate business of over 2 billion dollars a year. Among the commodities which are perhaps most extensively marketed through cooperative sales agencies are dairy products, fruits,

vegetables, dry beans, grain, cotton, eggs and poultry.

One of the outstanding cooperative enterprises is the California Fruitgrowers Exchange, organized in 1893 and in uninterrupted operation since that date. Today about 85 per cent of the citrus fruit produced in California and Arizona is handled by cooperative associations, 75 per cent of it by the Exchange (72 per cent of the oranges, 67 per cent of the grapefruit and 89 per cent of the lemons). The Exchange now ships nearly 33 million boxes of citrus fruit annually, the distribution being to all parts of the country. The organization is a simple federated plan. The growers are members of the local packing units which are affiliated with district exchanges, which in turn belong to the California Fruitgrowers Exchange. There are about 14,000 citrus growers who are members of the 200 local packing units. The Exchange functions in many ways as a service organization. It collects crop information, studies seasonal variations in consumer demand, export markets, loose fruit sales, advertising, nutritional research, transportation and other matters concerned with the production, packing, grading and distribution of citrus fruit. The Exchange did much of the necessary pioneer investigation of the conditions under which fruit could be shipped long distances in refrigeration with a minimum of loss. The utilization of byproducts of the citrus industry has been greatly furthered by the scientific researches conducted by the Exchange.

The Illinois Farm Supply is a good example of cooperative purchasing of supplies by farm groups. This Company serves as the wholesale organization for farmer-owned cooperative oil associations and is one of the 13 business units of the Illinois Agricultural Association. Petroleum supplies, principally gasoline, kerosene, distillate and lubricating oil, constitute 85 per cent of its business, but it also handles paint, insecticides, tires and more recently, feed, seed, fertilizers, fence, twine and similar farm supplies.

At least 6 federal government agencies make special loans to cooperative farm organizations. Such loans outstanding in 1942 totaled over $468,000,000. Naturally the structural plans of these 10,600 associations differ to fit the requirements of local, regional and wide spread groups, handling such diverse products as potatoes, paint, oranges, fence wire, and eggs. It is plainly outside the limits of this article to go into details about them. Any farmer who is not already a member of a cooperative may easily learn by inquiring what associations exist in his neighborhood.

COUNTY AGENTS

Many farmers have only a sketchy idea of the functions of Agricultural Experiment Stations, Agricultural Colleges and the U.S. Department of Agriculture, but it is a rare farmer who does not know the County Agent and the nature of his activities. In a real sense the County Agent is the living bridge, the liaison between all governmental agricultural agencies and the farmer. He interprets to the farmer the results of the scientific research carried on in those institutions. He brings to farmers the latest news on how to treat diseases of plants and animals, what to do about insect attacks, where to obtain pure seed, and good sires, what new varieties of crops are showing most promise. He helps in finding farm leaders to head the various local farm groups and organizations. He calls attention to new bulletins which may be particularly applicable in his county, tells farmers about market conditions. He is, in short, a sort of father confessor to the community and has a finger in everything that goes on in the countryside.

The County Agent carries on all these activities not merely by correspondence or telephone from his office, but by direct contact with individual farmers and in farm gatherings throughout his county. Until gasoline rationing began to curtail the extent of his travel, the County Agent practically lived in his car as a sort of circulating library of information for the benefit of the farmers whom he visited or casually met along the way. There is a County Agent in every rural county, something more than 2900 of them, or 4000 if you count their assistants. Credit is due them for helping significantly in improving the social side of farm life as well as in bettering the yield of crops and raising the standard of farm live stock.

DAILY INCOME

One of the most difficult problems in planning a farm as a reliable source of income is that of having a sufficient number of enterprises which fit together smoothly and provide regular employment the year round. The questions to be answered are: How many days a year does your farm give you employment at productive work? It is a regular or only

part time job? How much of this work is merely pottering around? How many days of the year does your farm lay you off without pay?

For example, take the exclusive spring wheat drylander in the Rocky Mountain States. He works perhaps 3 weeks in April and May preparing the ground and seeding. Then in August he has another job harvesting it, lasting about a fortnight. The rest of the year is largely vacation without pay. And it is a rare man that can stretch a year's income over 12 months if it is received in a single large check. The Palouse farmer's job is a little longer for the reason that he does considerable summer fallow work and may grow oats and peas as well as wheat. But his farm hires him for productive work for only 100 to 120 days of the year.

But no one-crop system really gives steady employment. The lambing season is a busy time for the sheep raiser. Cotton must be cultivated at the right time and picking is no sinecure. Potatoes must be sprayed or wilt and insects will play havoc with them. But the most detailed system of time keeping on a one-crop farm fails to account for more than 3 to 6 months of the year, except perhaps in the case of tobacco. Corn gives the farmer 4 busy months, cotton 5, potatoes 4, sugar beets 7, tobacco 8 or 9, alfalfa 3, apples 4, wheat 2 to 4, and beans 5. Even in the busiest months there is enough slack time to take care of a cow, pig, chickens and garden. The main fault of the single-crop system is that the work nearly all comes in 1 or 2 heaps with little to do in the intervals. And nature has to be reckoned with. The weather does not permit continuous field work. Jobs should be provided for rainy days. In Chester County, Pennsylvania, there are only about 175 days a year available for field work, 200 days a year in Arkansas and corresponding periods in other regions. Bankers are unanimous in considering the man with a diversity of crops and enterprises on his farm as a better financial risk than the one-cropper. In a cost-accounting survey of 350 dairy and general farms in New Jersey, the records show that the farms so planned as to give the owner 300 days' employment a year produced 4 times as big an income as those which furnished only 150 days' work, while those which supplied only 110 days' work were operated at a loss under similar conditions. Making maple sugar is a job which has defied most cost accounting, while proving the importance of steady employment. Most statements of the cost of making maple sugar have shown that it was produced at a loss. Yet the farmer who taps his maple trees knows that the maple sugar season gives profitable employment for an otherwise idle 2 to 3 weeks. In the little chinks and crevices of time between the main job the farmer pulls a few weeds out of the onion bed, cleans the grass away from the bee hives, throws a cabbage or lettuce into the chicken yard, gives the necessary morning and evening service to his live stock, brings in supplies for the family and takes something to market for cash No one crop can possibly provide an income every day.

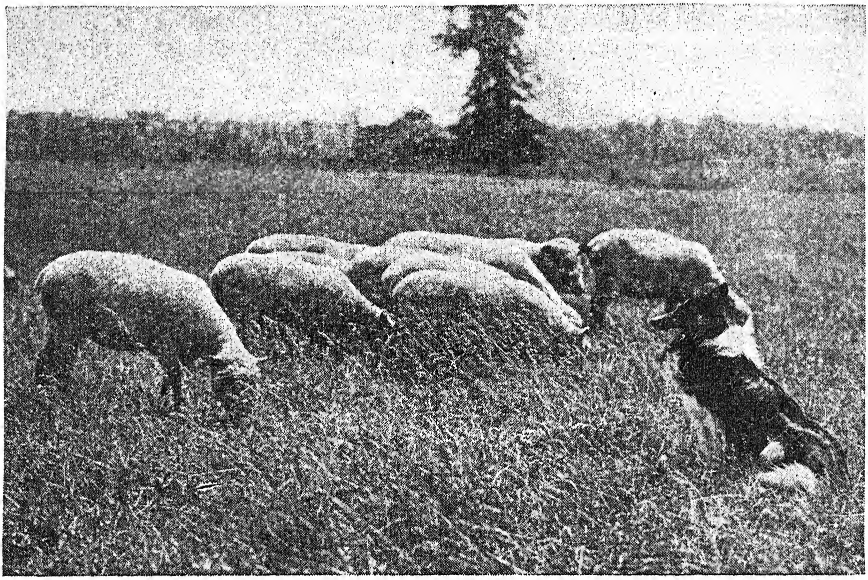
DOGS

Dogs have been domesticated and used by man for various purposes since the earliest records obtainable of man's doings. The breeds of dogs are perhaps as numerous and show as many fundamental differences as in any other species of domesticated animal. All travelers have observed certain distinctive peculiarities in the common breeds of dogs in different countries. In general there is a greater or less resemblance between the domesticated dogs of a country and the wild species of the dog family. For example: the Esquimaux dog resembles the large gray wolf, and the Indian dog possesses certain resemblances to the coyote. It is impossible to determine whether the various breeds have been developed from a single wild species, or from several. It is probable, however, that a number of wild species became domesticated in different countries and that the present great variation among dogs is due to the differences in the original species from which they developed and to various crossings which have subsequently taken place. Domesticated dogs cross freely with wolves, jackals and other wild breeds of the dog family, and the hybrids thus produced are fertile to some extent. The common Indian dogs of the Western States show great resemblance to the coyote in their form, color and voice.

The marked tendency to variation and power of adaptation to changed conditions have made it possible for dogs to be utilized by man for a great variety of purposes. No details of the uses to which dogs are put can be mentioned in this brief account, but it is sufficient to call attention to the development of very different types of hunting dogs used in the pursuit of various game birds and mammals, to dogs used as draft animals and

beasts of burden, and to sheep and drovers' dogs which are so indispensable to the management of sheep and cattle, one of the most valuable kinds of which is the Scotch Collie.

While dogs may be of great use and value upon the farm, they may also be a source of nuisance and trouble, and it hardly seems advisable to keep any but healthy, vigorous animals, which show a tendency to be useful for some purpose, or at least manifest no bad habits. Dogs may be instrumental in carrying various diseases, such as glanders, anthrax, tuberculosis, etc. Their well-known habit of eating carrion make it possible for them to spread these diseases by feeding upon the carcasses of dead animals. All such carcasses should be destroyed by burning or burying. In many States the sheep-killing tendencies of mongrel dogs have greatly checked the sheep industry and have caused enormous destruction of these animals. It is obvious that dogs which are not provided with a home and properly cared for may be harmful rather than beneficial.



SHEPHERD DOG GUARDING THE FLOCK

Wild dogs were carnivorous but through generations of close association with human beings, modern breeds of dogs have adapted themselves to the same ration as man. On the farm kitchen scraps, supplemented by an occasional capture of wild game, give dogs an adequate ration. Canned dog feeds of various brands are available, and in many cities there are canine caterers who make a business of supplying such materials. The Alabama Experiment Station after the study of the nutritive requirements of dogs, recommends a ration composed of corn meal, bran, shorts, meat scrap, fish meal, dried buttermilk, alfalfa meal, bone meal and salt.

Since the dog tick (*Dermacentor variabilis*), also called wood tick, is the carrier of Rocky Mountain Spotted fever and also tularaemia, both of which are serious diseases when transmitted to man, dogs should be frequently examined for the presence of these ticks at least from June 1 to September 1. If dogs are allowed free run in infested localities they may pick up scores to hundreds of ticks every day. Dog ticks are particularly abundant along the east and west coasts but are generally distributed throughout the U.S.

Diseases: MEDICINES. For an account of the medicines and of the doses mentioned under the diseases below *see Veterinary Medicines*.

DISTEMPER is a malignant, contagious disease due to the action of a bacillus, and affects dogs, cats and related carnivorous animals. Animals suffering from this disease lose their appetite and show a

considerable elevation of temperature. There is usually a discharge from the eyes, which is at first watery but later becomes thick and yellow in color. A catarrhal condition is present in the lining of the nose and extends later to the bronchial tubes and lungs. Ulcers may appear on the mucous membrane of the nose. In most cases a persistent cough is noted and the breath has a disagreeable odor. Occasionally affected animals become excited and have spasms, but usually they are much stupefied. The disease is a very serious one and from 50 to 60 per cent of the cases die. If an animal is valuable enough to warrant treatment, the eyes may be washed with a 5 per cent solution of borax or a 1 per cent solution of carbolic acid. For controlling the temperature phenacetin or acetanilid may be given in 2-gram doses every 2 hours. As a tonic, 5 drops each of dilute hydrochloric acid and tincture of nux vomica may be given in water 3 times a day.

Rabies or Hydrophobia is an acute disease of the nervous system which is transmitted by means of the bites of mad dogs or other animals, and is due to a virus. The disease attacks dogs, cattle, horses and other domestic animals as well as man. The extent of the disease is not so serious as is often believed from exaggerated accounts. The symptoms of rabies usually appear in from 3 to 5 weeks after the animal is bitten. In man the disease appears after about 72 days. The symptoms of rabies vary greatly in different species of animals which are affected and may often closely resemble those of tetanus or lockjaw. In cases of the latter disease, however, there is no evidence of viciousness. Animals affected with rabies show violent attacks of the disease from time to time, during which they bite at man or other animals and transmit the disease in this manner. In dogs, the disease manifests itself especially as an uneasiness which compels the animals to run about violently for periods of considerable length, while these acute attacks are followed by periods of stupefaction. Affected horses may bite or kick at the slightest noise or moving object. The ears are held erect and the eyes stare. Between the acute attacks the animal may eat and drink. The treatment of rabies in man consists in successive inoculations of weakened virus, according to the Pasteur method. This treatment may be obtained at the various Pasteur institutes in the different States. A similar treatment of domestic animals would probably be equally effective, but is too expensive in most cases, and such animals should be immediately destroyed, in order to prevent their spreading the disease by biting other animals.

Dogs Distribute Sheep Tapeworms. Considerable importance attaches to the problem of the relation of the dog to the sheep industry. On large sheep ranges dogs are almost universally used to help the herder in the management of the sheep. On this account it is unfortunate that the dog should also be so common and important an agent in the distribution of the most injurious tapeworms of sheep. According to some authorities the common tapeworms which occur in the intestines and bile ducts of sheep are the cause of great losses in these animals, and since these tapeworms live during one of their stages in dogs it is easy to see how dogs may be the means of spreading the tapeworm eggs over the grass upon which the sheep feed. Sheep dogs or other dogs which are allowed in sheep pastures should be treated periodically for tapeworms. Perhaps the best remedy for this purpose is areca nut given in doses of 2 grains to each pound of the dog's weight. The dose will, therefore, vary according to the size of the dog. This treatment should then be followed after 2 hours by a tablespoonful of castor oil. The presence of tapeworms in dogs usually causes no striking symptoms, and therefore the extent of infestation by these worms is not fully appreciated. Coyotes and wolves are also instrumental in distributing tapeworm eggs in the same manner as dogs.

Fleas are a common, well-known pest of dogs and cats, and also infest houses to considerable extent. The larvae of these insects require dark, moist places for their development, such as are furnished by cracks in the floor or heavy carpets which remain down during the whole year. In houses with smooth floors covered with rugs and frequently swept, fleas never become a great nuisance either in the household or upon domestic animals. If dogs and cats are allowed about the house they should be provided with a rug to sleep on, and this rug should be frequently shaken or otherwise treated for the destruction of fleas. A badly infested dog may be washed with soapsuds or thoroughly dusted with pyrethrum powder.

Mange or Itch is a disease which is common to dogs and various domestic animals, as well as man. The disease is due to the presence of a mite of flattened

and circular form which burrows in the skin, causing an itching sensation and the development of pustules or scabs. The treatment for this disease should be the same as for sheep scab. When sheep are being dipped for scab, the dogs should be thrown into the vat along with the sheep. (*See* under *Sheep*.)

DUST EXPLOSIONS

Destructive and often fatal explosions of finely pulverized dust are of frequent occurrence in industrial plants as well as in the running of threshing machines, and other farm operations. Long continued chemical investigations have shown that almost any vegetable or mineral substance, if pulverized to a sufficient degree of fineness, will explode if ignited by an electric spark. Rapidly revolving parts of machinery may generate enough frictional electricity to produce sparks. The clouds of smut spores and other fine dust about a threshing machine in operation, have frequently exploded with violence. The natural method of prevention of such disasters consists in grounding all revolving parts of the machine so as to lead the electric current into the ground before the pressure becomes great enough to emit a spark. Even in experiments with new methods of desiccating foods some trouble has been experienced, as for example, in the case of dried and pulverized onions.

FARM CREDIT

The importance of proper credit facilities is as great in farming as in any other occupation. Few beginners are in position to lay down the cash for a farm and the necessary equipment of machinery and live stock. Long term credit is required for such a venture. That means a mortgage on the real estate. The one-crop farmer is in the most precarious situation. His income is a once-a-year event. The wheat crop, for example, brings the farmer no funds till it is harvested. He borrows, therefore, to finance his operations up to the time of threshing. Then, if grasshoppers, drouth, and hailstones have compassionately passed him by, he can pay off his indebtedness with his wheat check. If not, he must arrange for an extension of credit.

The volume of farm mortgages has a way of following the ups and downs of farm land values. Our total farm real estate value in 1910 was estimated at 35 billion dollars; by 1920 it was set at 66 billion; but by 1924 had fallen to 16 billion. While land values skyrocketed to almost unheard of heights, 5 billion dollars additional were borrowed by plastering the farms with mortgages. Thus in one decade the farm debt increased 2½ times. One of the results of this flurry was the foreclosure by forced sale of 2,100,000 of our 6 million farms. In the depression years which followed, these foreclosures and scale-down of debts reduced the aggregate farm indebtedness to 7 billion dollars. Whether mortgages and farm land values will start soaring again as an aftermath of the present war, remains to be seen.

The sources of money for farm loans are many and varied. Of the 7 billion now loaned on farms about 3 billion came from individual lenders, often relatives or neighbors of the borrowers; about 1½ billion from commercial banks and insurance companies, and the remaining 2½ billion from the various lending agencies under the Federal Farm Credit Administration. A long term farm mortgage credit system has been in operation since 1917. These loans were made repayable in annual or semiannual installments over a period of 20 to 33 years by the familiar system of amortization. Later provision was made for short term loans. In the system 12 farm credit districts were created to cover conveniently the whole country, and in each of these districts there is a Federal land bank, a Federal intermediate credit bank, a production credit corporation and a bank for cooperatives. All four institutions in each district are located in the same city and same building, the locations being Springfield, Massachusetts; Baltimore, Maryland; Columbia, South Carolina; Louisville, Kentucky; New Orleans, Louisiana; St. Louis, Missouri; St. Paul, Minnesota; Omaha, Nebraska; Wichita, Kansas; Houston, Texas; Berkley, California; and Spokane, Washington.

The purposes for which loans have been made from the Federal land banks were 62.5 per cent for refinancing indebtedness; 28.5 per cent for purchase of land; 5.5 per cent for buildings; 3.5 per cent for purchase of farm loan stock. Production credit has helped the farmer meet the expanded goals for poultry, pork, milk, eggs and other farm operations, and in the purchase of machinery and emergency supplies.

FARM ELECTRIFICATION

The use of electricity on farms has been brought more prominently to public attention by the Rural Electrification Ad-

ministration since its creation in 1936. Before the establishment of that agency telephones had been installed on 2,140,000 farms and electric lights on 850,000 and the use of electric power for feed grinding, sawing wood, heating, cooking, running milking machines and for other farm operations in thickly settled farm communities within reach of large power developments. Farm utilization of electric power had until recently progressed much farther in Norway and Sweden than in the U.S. by virtue of the unusual supply of hydro-electric power which those countries enjoyed, even to the rather wide use of the electric current for heating the soil of truck gardens to hasten the growth of early garden crops.

Since 1936 the federal government has loaned 460 million dollars in 45 States to promote the further use of electricity on farms. At present electrified farms constitute from 6 to 92 per cent of the total farms in the various states, Rhode Island standing at the head with 92 per cent, followed by Connecticut, Massachusetts, California, New Jersey, New Hampshire, and Ohio. The purposes and appliances in which electricity is used on farms are almost without number. These include lighting poultry houses, heating brooders, pumping water, cooling cream, separating milk, grinding feed, curing sweet potatoes and tobacco in storage, refrigeration, quick freezing, ham curing, drying alfalfa and other hays, and soil heating in addition to the operation of scores of gadgets in the farm buildings and farm homes. There are still 4 million farms in the country without electricity for lighting or power, and progress in electrification has been brought to a standstill by the stress of the military need of copper and other metals.

FARM LABOR

Within 25 years, or the length of a generation, we have been engaged in 2 world wars. Wars take men for military service from every trade and profession. In this sudden draft of man power the farmer feels the drain first and perhaps most acutely. His hired men and his own sons, even if not drafted for the fighting lines, are likely to be lured into munition plants by the high wages of war time. At the same time the farmer is asked to produce more food than in time of peace. How is it to be done? Obviously it is necessary to learn as quickly as may be the extent of the labor shortage on the farms in each locality and simultaneously ascertain sources of supply of labor in villages and cities to meet the emergency.

In the first world war a rapid-fire census was taken through the public school system of the cropping plans and additional labor needs of the farm. School children took home the census blanks and turned them in as soon as they were filled. The County Agent summarized the reports for each county and the State farm labor specialist tabulated the statistics for his State. In that manner complete data were in the hands of the Office of Farm Management in the Department of Agriculture within one month after sending out the questionnaire.

The next move was to appeal to the population of cities and towns for volunteers, men, women and children, to fill the need. More than 500,000 such volunteers appeared for duty. In a similar future emergency that is only a fraction of the manpower that could be relied upon for extra farm work. There are at least 700,000 retired farmers who could fill much of the shortage of skilled work, milking cows, feeding stock, and handling farm machinery. School children by the million, under sympathetic direction can pick fruit, tomatoes, and potatoes, and learn in a week's time to do many simple chores about the farm. But women are the great source of labor for short-time fruit harvesting and similar jobs. In the last world war they did their part in the campaign for more food. Moreover, in most country towns a large percentage of the population are only one generation away from the farm. In many such towns 40 to 50 per cent of the citizens were born on farms.

The farm labor situation should also be considered with reference to the future of agriculture. About ⅓ of our farm owners start in as hired men. The regular hired men range in age from 17 to 60, but most of them become tenants by the age of 25, and begin climbing the agriculture ladder toward the status of ownership.

The qualifications of a good farm hand are rather exacting. He must have the "agricultural squint." He must be able to see the beauty and poetry as well as the potatoes and alfalfa in farming. He must be a clean-minded, companionable fellow, for he should become a member of the family. Then there come skill and the living sympathy with farming which is born of intimate experience. The cowboy, like the poet, is born not made, and the same may be said for the sheep herder, the stock feeder and all the other

regular farm hands. This man must have initiative and know what to do in a hundred emergencies. His tasks are legion. They include shoeing horses, setting tires, painting wagons, mending harness, cement work, breaking colts, applying sprays against insects and diseases, caponizing fowls and innumerable other chores.

This regular farm hand is the fellow who is really indispensable in an emergency. A call for harvest help can and always has been met easily and satisfactorily. The pinch comes not in getting the harvest under cover but in getting the crop produced. In the spring of 1943 we faced the prospect of a reduction of 15 to 20 per cent in the acreage planted to vital crops by reason of the shortage of skilled labor on farms, men capable of plowing and cultivating. For example, in Jefferson County, West Virginia, Neil Bolton, the County Agent, estimated, by a careful survey of the county, the possible corn acreage at 20 per cent less than in 1942. This land is usually plowed by the first open weather in January, while in 1943 none of it had been done before March, and the help to do it was not in sight.

The problem of farm labor is not a new one. It has always existed and there are other facets to the question. The farmer complains of inefficiency in farm hands and the farm hand complains of housing conditions, poor food and bad treatment. The laborer complains more of irregularity in hours rather than the length of the day's work. He often resents the fact that his social status is indefinable since he seems to be in the family but not really a member of it. In an era of high farm prices and high industrial wages, both the farmer and the hired man are likely to become a bit unreasonable. The farmer thinks the laborer asks too much for his work and the laborer feels that the high prices of farm products should automatically be reflected in his wages. This situation requires a little mutual adjustment but is in no case a new phenomenon or more difficult than the problems of labor in industry.

FARMING PART-TIME

Since the census definition of a farm is a "tract of land at least 3 acres, which is used for agricultural production, or if smaller, produces annually at least $250 worth of agricultural produce," it is obvious that many farms are not large enough to support a family and that part of the income is derived from industrial or other work in the nearest city. About ⅕ of the farms in the U.S. are 20 acres or less in size. There are no reliable figures on the number of part-time garden farming by urban workers. But we know that the number is constantly and rapidly increasing.

In Rhode Island a study of 1100 households combining agricultural production and non-agricultural employment brought to light many interesting data regarding this movement. "The families have members who have jobs of nearly full-time employment in the city. Most of them have lived at their present location since 1930. A large proportion have ownership equity in their homes."

Over 60 per cent of these Rhode Island part-time farms were less than 3 acres in size. In some families the mother or sons, or daughters worked in the city in addition to the male head of the family. The number of hens per farm varied from 12 to 450, progressing from the family size flock to that of the commercial poultryman.

In Rhode Island, rural dwellers who make use of land for non-agricultural production outnumbered the commercial or full-time farmers. But in Rhode Island there is only 1 acre of land per person in the State while in Texas there are 30 acres per inhabitant, and 24 acres in Maine. The long-time trend is distinctly in the direction of suburbanization of city dwellers into some degree of part-time farming. This trend is of course disturbed by the abnormal massing of war-workers in new war-time factories, but it will probably return to the normal condition.

FARM PLANNING

The large annual variation in the acreage of such crops corn, cotton, wheat and potatoes is one of the familiar features of the statistics of agriculture. The cause of this wabbling is not at once obvious or simple. Do all farmers change their plans from year to year in about the same degree and in the same direction? Or is there a recognizable difference in this regard between good and poor farmers? In plain language is stability of plan related to success in farming?

Some of the available evidence on this question may be presented in the following paragraphs.

A survey of the records of a group of Maine potato growers showed that the farmers who held steadily to about the same acreage year in and year out made more money in a six-year period than those who changed their acreage up and

down. At the time of this survey there had been for 25 years, with striking regularity, a large crop of potatoes with low prices every other year and a small crop with high prices in the intervening years. One farmer had planted 10 acres of potatoes in 1916, 1918 and 1920 and 20 acres in 1917, 1919, and 1921. He had guessed wrongly every time, for his big acreage fell uniformly in years of low prices, and his small acreage in years of high prices. A simple calculation of the returns for the 6 years, as recorded in the prices in his own books, showed that if he had grown 15 acres every year instead of alternately 10 and 20, he would have been $800 ahead.

In a group of 100 farms in Ohio, in which each farm was operated without change of ownership during the 11 years covered by the study, the exact acreage of every crop on every farm was recorded for each of the 11 years. Corn was a major crop in this region. Using corn as a measuring stick for the variation of acreage from year to year, and arranging the list of 100 farms in the order of the extent of their wabbling in acreage, and beginning with those who wabbled least, it was found that they were thus also arranged in the order of their financial success. The best farmers had deviated only 12 per cent in any year from the average of corn on their farms, while the poorest ones had varied 26 per cent. Similar records for a group of Indiana farmers showed that the good farmers never got more than 9 per cent out of plumb, while the poor ones leaned over more than 15 per cent. Corresponding figures for some Wisconsin dairymen were 8 and 15 per cent. The mere fact that in these 4 types of farming the poor farmers wabbled twice as much in their cropping plans as did the good farmers, is significant. It is not an accident nor an isolated phenomenon. It brings into sharp contrast the man who finds out as soon as possible the best plan of cropping for his farm, and then sticks to it through all kinds of economic weather, and the other man who guesses and changes, trusting to luck and weather.

In these surveys the records of one farmer showed that for 10 years he had not stuck to the same plan 2 years in succession. He had dabbled in beans, sugar beets, potatoes, rye, oats, vetch, alfalfa and soy beans. He had 3 breeds of cows, 2 breeds of sheep and 4 breeds of chickens. The farm was merely an experiment. The owner seemed unable to decide what to grow on it, nor how much, nor in what order or proportion. He simply changed his plan each year because last year's plan worked out poorly. The contrasting type of farmer explained his system in some detail. Of his 240 acres in crops, 10 acres were in permanent blue grass pasture. Corn occupied 80 acres regularly. His rotation plan carried corn 2 years in succession. Each year 40 acres of corn were planted on clover sod and the other 40 on corn stubble land. For the next year one-half of the corn patch goes into corn again, and the other half to oats, followed by wheat in the fall, and seeded to clover for return to corn the following year. With such a systematic plan this farmer had so uniformly distributed the labor load through the year that with the help of one hired man he could do all the work on the 240 acres, except an extra man a few days for the oat and wheat harvest.

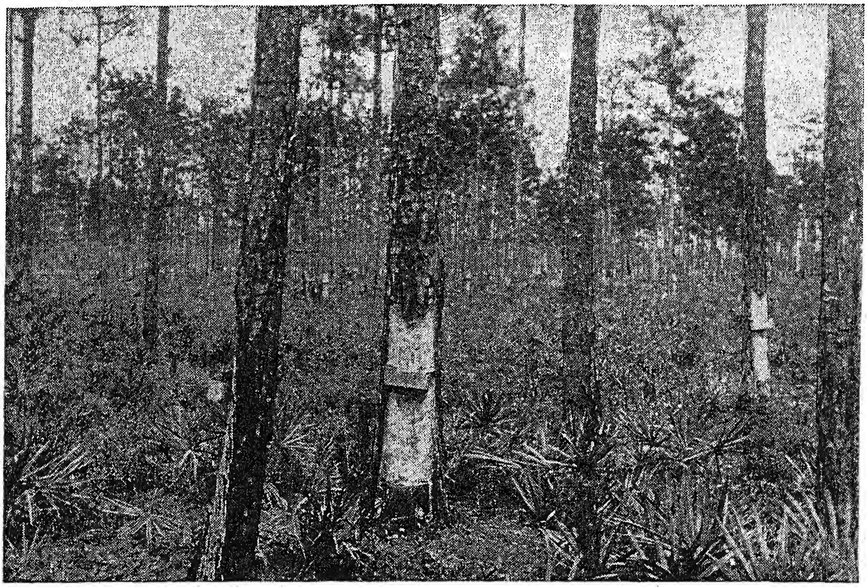
Evidently to have a well considered system of crop planning based on experience, and to follow it steadily, is a symptom of good farming. The average labor income of the 10 best men in the Wisconsin dairy group was $1054 a year, while the planless 10 at the bottom lost $254. From such farm records as are available it might be concluded that about one farmer in three operates on a definite plan for which he can give good reasons. The percentage should be higher.

FORESTRY

A cynic once remarked that this old earth got along quite nicely for ages before man appeared on the scene, but that man has proved to be the most destructive of all animals. The roots of our attitude toward trees reach back into the beginnings of our colonial history. The first settlers of New England and Virginia literally carved their homes out of the wilderness. They needed trees for fuel, for lumber to build houses, barns and stockades, and to make furniture. They needed clearings in which to plant crops for food. The endless stretch of trees was called the wilderness. The forests seemed an obstacle in the way of progress. They furnished shelters for Indians, wild beasts and mosquitoes. The forests were cleared to make room for civilization. In a few generations our forefathers cut their way through woods to the Mississippi. Pressing on into the treeless prairies they missed the forest shade and wind protection, and began to plant trees. That briefly summarizes early American association with trees from the staccato music

of the woodman's ax to the sentimental songs of Arbor Day. Looking back over these events it is evident that the man with the ax was not always a vandal, and the Arbor Day orator did not always know any too much about trees.

A wood lot is an important feature of a farm. Under reasonable planning it furnishes an annual supply of fuel for farm use and a surplus for sale as a cash crop. Every year a few trees reach lumber maturity and should be harvested to make way for their natural replacement by the oncoming younger growth. A well kept wood lot is recognized by land bank assessors as an important item in estimating the value of the farm. Some of the woodland on farms may be pastured without damage to the tree growth and furnishes much enjoyed shade for live stock in the heat of midsummer. Even the "sugar bush" of maple should be treated as a lumber crop as well as a source of sugar. Maples reach an age when their sugar production declines and when they should be harvested as timber.



TURPENTINE ORCHARD IN FLORIDA

Forests should be treated as a crop, perpetually renewable by young saplings. Sweden and Finland harvest pulp wood from their vast coniferous areas, removing timber at about the same rate as that of reforestation. In this country we can do likewise and must do so if forests are to be a continuous and unfailing crop. Trees mature slowly and require long time planning. In parts of Europe oak plantings have been made to be harvested 300 years hence. The father must plan for his sons, grandsons and future generations, if they are to inherit trees. This is a more complicated job than sowing wheat for next year's harvest. Planning and financing must be on a different basis. Even with the rapid-growing pulp wood timber the rotation period may be from 20 to 50 years. This is no 6-months' hop-in, hop-out affair. Trees teach calmness, foresight and faith in the future.

About 800 million acres of the U.S. were originally forest. There are still 500 million acres in fairly good condition, all but about 200 million acres in private ownership. The federal and state governments own some 190 million acres on which a system of planned forest management is maintained. A more rational use and protection of these vast privately owned forest lands could be encouraged by adjusting the tax laws and credit facilities so that forests would become more desirable property, and reforestation a reasonable investment.

A study of the value and influence of forests on agricultural and industrial interests has brought to light the intimate relation between forests and water supply

throughout the country. The most striking illustrations of this fact are to be had in the Western States, where irrigation is necessary for successful agriculture. The presence of forests in such situations is an extremely important factor in preventing the rapid melting of snow and superficial run off of water. The results of deforestation are readily observed in floods of greater or less severity, and in scarcity of water at times when it is most required. The preservation of big game in Western States in their present numbers also requires the existance of large areas of timbered land as nearly as possible in its natural condition. But of more importance than anything else is the influence of trees on the appearance, comfort and actual value of the farm house.

The federal government, since the early days of the great westward homestead movement following the Civil War, has in various ways fostered the natural human instinct of planting trees in treeless areas. The Timber Culture Act passed in 1873 enabled settlers to acquire title to 160 acres of land on condition of growing a certain amount of timber. Thousands of homesteads were thus acquired, but in drouth years the young trees required watering which was not always done. Recently extensive plantings were made as a shelter belt across the Great Plains as a windbreak against the sweep of air currents over the treeless country, and with the hope that the presence of trees might increase the local rainfall.

In Florida and other Southern States the production of turpentine and rosin in the extensive areas of pine is a highly important industry, about 235,000 barrels of turpentine and 1,150,000 barrels of rosin being obtained annually from these trees. Wood-pulp production in the U.S. has reached a volume of nearly 9 million tons annually.

FROGS

The rather uniformly good prices which are obtained for frogs in market have led a number of persons to attempt the business of frog raising for profit. Newspaper accounts occasionally appear describing in somewhat exaggerated terms the profits to be derived from this business. Where farmers own land enclosing or bordering upon marshes which cannot economically be drained and used for other better purposes, some returns may be obtained for time expended in encouraging the breeding of bullfrogs in such locations. Frogs may be brought in from other localities and colonized in the marsh where it is planned to raise them, and in this way their numbers may be so increased that they may be profitably captured for market. The returns from this business, however, have never been large and the enterprise can hardly be recommended to the average farmer, especially since, as a rule, time expended in giving attention to frogs could be more profitably used in other directions.

FROZEN FOOD LOCKERS

The provision of refrigerated storage available to individuals for such perishable farm products as meat, eggs, fruits and vegetables was first started in Chico, California, by the local ice company in 1903. The service was first offered to merchants for the storage of eggs and apples, but was soon extended to farmers for the storage of meats, and individual wood lockers came into use in 1913. Somewhat later an ice plant manager in Centralia, Washington, offered refrigeration facilities to hunters for the storage of game, and to farmers for the storage of home butchered meat supplies. This convenience in handling home food requirements became so popular that the movement spread rapidly throughout the far west to creameries, ice plants and milk depots, still, however, being confined almost exclusively to regions west of the Mississippi.

But, according to L. B. Mann, "since 1937 the development has spread into Indiana, Ohio, other Eastern States and throughout the South. Recent reports indicate that there are now over 200 locker plants in Iowa, 200 in Washington, 62 in Minnesota, 42 in Wisconsin and over 2500 in the whole country, while others are being established at the rate of 50 or more a month. The capacity of these plants is about 850,000 lockers with an annual storage volume of about 500 pounds each."

These plants are owned by individuals, partnerships, cooperatives, butchers, ice plants, creameries, cheese factories, and corporations. Complete butchering and curing service for meats is provided at many of the locker plants, the total cost of such service, including annual rental for the locker, running between 4 and 7 cents per pound of meat.

Thus far refrigerated lockers have been used for meats more than for other food products. But berries, cherries, grapes, peaches, asparagus, beans, peas, corn and spinach may be safely preserved by the

freezing process. Tomatoes and lettuce will not stand freezing.

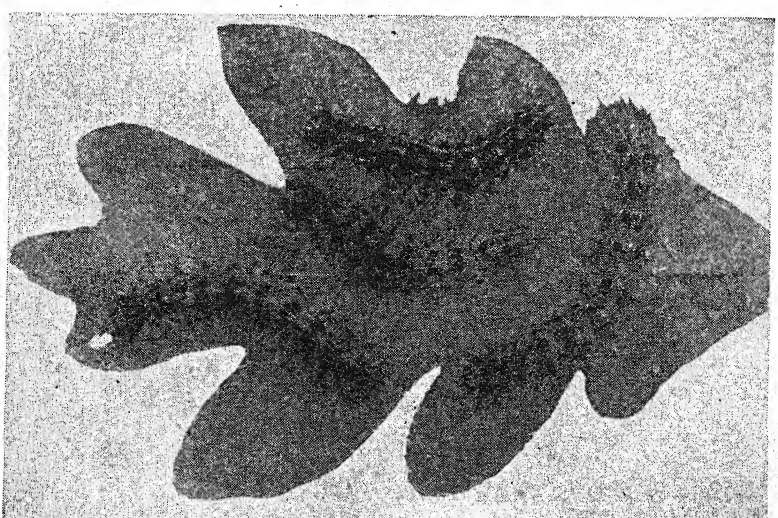
Among the advantages enumerated for frozen locker plants mention may be made of the fact that frozen home-produced meats are usually more palatable than home canned meats, and that an improved diet for the farm family is made possible by storage of fresh frozen meat during periods of the year when it is impossible to keep it on the farm. With a per capita meat consumption of 135 pounds per year a family of four would require 540 pounds a year. The average service charges at frozen locker plants make possible a considerable saving in the cost of meat for the family in the course of a year.

GROUND SQUIRRELS

Ground squirrels or more properly spermophiles, are also often called gophers, although the term should be reserved for an entirely different family of mammals, the pocket gophers. Five or more species of ground squirrels are found in the valley of the Mississippi and its tributaries. They extend westward to the Pacific Coast and eastward as far as Michigan and Indiana. Ground squirrels are everywhere recognized as important enemies of agriculture, on account of their habits of feeding on cultivated pasture grasses and grains. The ground squirrels are especially injurious in fields of grain, which they destroy in great quantities. In cultivated fields they are also harmful on account of the large mounds which they throw up in digging their burrows.

Prairie Dogs. These animals, the largest of the ground squirrels, are generally distributed throughout the Great Plains and occur in colonies (dog towns) of varying size. The largest colony is in Texas and covers an area of 100 by 250 miles, or 25,000 square miles. The average number of prairie dogs per acre is about 25, and it has been estimated that 32 prairie dogs will eat as much as one sheep, and 256 as much as one cow. In the region of the dog towns the destruction of grass is estimated at 50 to 75 per cent of the range capacity. Unusual efforts are being put forth to destroy these animals especially in Kansas and Nebraska and their numbers are being somewhat reduced. Their effect upon the range grasses, however, is still apparent even to a casual observer.

The most natural enemies of ground squirrels are badgers, hawks, owls, foxes and coyotes. The burrowing owl often destroys the young of prairie dogs. These animals have similar feeding habits to the ground squirrel. The badger is everywhere an important enemy of the ground squirrel. They are slow of movement on the surface of the ground, but burrow with great vigor and persistency. In many localities the ground squirrels have been completely exterminated by the badgers, which latter have finally migrated from the locality, leaving the old burrows of both animals uninhabited. The offer-



GYPSY MOTH CATERPILLARS ON OAK LEAF

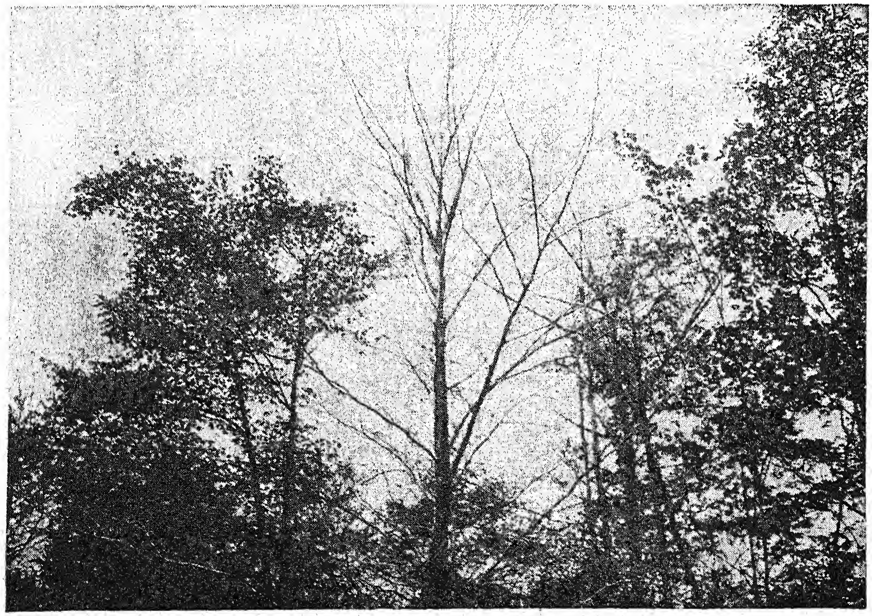
ing of bounties by State governments for the destruction of ground squirrels has usually proved unsatisfactory. These pests may be successfully combated by the use of irrigation water, where this can be had in large quantities, or by carbon bisulphid. The last named method consists in pouring about an ounce of carbon bisulphid into the burrow and closing the burrow immediately thereafter. The fluid may be poured into the burrow directly from the bottle, or perhaps preferably a wad of cotton or other substance may be saturated and rolled into the hole. Poisoning with strychnin is less effective and is unsatisfactory, on account of the danger of poisoning other animals. Traps and fumigation with sulphur have been used with success in many localities. The meat of young squirrels is tender and of a delicate flavor and the animals are often hunted as game.

GYPSY MOTH

The Gypsy Moth was brought into Massachusetts in 1869 as a possible silk insect. Some of them escaped from the experimental laboratory. The moth increased very slowly at first, and drew little public attention for 20 years or more. Then from 1900 to 1905 it spread enormously. By 1934 it had covered all New England and had reached New York City and the Hudson River north to the Canadian line. The gypsy moth feeds upon the leaves of a hundred species or more of forest trees and often completely defoliates large areas of woodland. The federal Bureau of Entomology cooperates with the infested States in a campaign of quarantine, clean up and insecticide operations.

The moth lays 100 to 800 eggs in a cluster on the trunks of trees, under side of limbs, sometimes in stone walls. Creosote applied with a brush to the egg cluster will easily destroy them. The caterpillars seek shelter on hot days and may be readily trapped in burlap bands around the tree trunks. Small colonies of gypsy moth later appeared in New Jersey and Pennsylvania, but these have been eradicated, except in a few localities in Pennsylvania.

The **Brown Tail Moth,** another pest introduced into Massachusetts in 1897, causes great damage by defoliating fruit and shade trees and oak woodlands in early spring. It has already spread over practically the same territory as that of the gypsy moth. The bodies of the caterpillars are covered with poisonous hairs which cause serious irritation and swelling when they come in contact with human skin. Fortunately a fungous disease destroys many of the caterpillars.

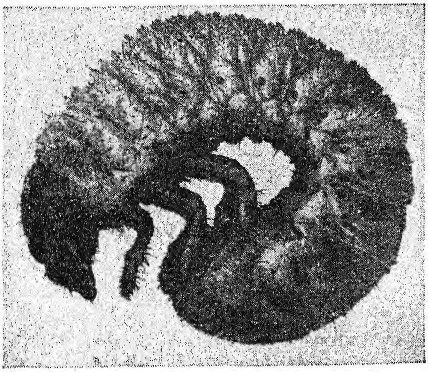


BEECH DEFOLIATED BY GYPSY MOTH

The caterpillars pass the winter in masses in webs. These webs should be cut from the trees and burned.

JAPANESE BEETLE (*Popillia japonica*)

The Japanese beetle accidently introduced into New Jersey from Japan in 1916, has already made an unenviable reputation for itself as an allround pest. It has spread to all States east of the Mississippi, but is a serious nuisance in



JAPANESE BEETLE GRUB

only a few States along the Atlantic seaboard. The beetle is metallic green in color with coppery brown wing covers. The larva is a grub closely resembling that of the June beetle. The adult beetles appear about June 10, or later in the southern part of their range, and are active from 30 to 45 days feeding on a great variety of plants. The eggs are deposited in lawns, meadows or pastures. The beetles eat the leaves of various trees and roses, fruits, the silk of sweet corn and such truck crops as beans, asparagus and rhubarb.

Two species of a parasite called Tiphia have been introduced from Japan and are helping materially in destroying the beetles. Lawns may be protected by applying lead arsenate preferably before July, at the rate of 10 pounds per 1000 square feet, having previously mixed the arsenate with 25 times its volume of moist sand or soil. The beetles may also be destroyed by spraying with ground derris at the rate of 5 ounces of derris and 5½ ounces rosin emulsion to 10 gallons of water.

LOCUSTS

The term locust is frequently applied to the cicada or 17-year locust, but should more properly be reserved for the group of insects commonly known as grasshoppers. These insects are too familiar to require any description for identification. The eggs are laid in masses and covered with a glue-like substance. They are deposited in the ground or in dead wood. There is only 1 generation per year and the winter is usually passed in the egg state. All species of locusts are injurious to some extent but several of them multiply in such numbers as to cause great destruction of cultivated plants. The more destructive species are usually arranged in 2 classes according to their habits, migratory and nonmigratory. Among the most noted species of locusts mention should be made of the Rocky Mountain locust, the lesser migratory, red-legged, 2-striped, differential, American, pellucid winged, long winged, pale winged and devastating locusts. The Rocky Mountain locust is generally considered the most destructive of all these species and has occurred at various times in such numbers through certain Western States as to cause a veritable plague. This species occurs permanently in the Rocky Mountain region and extends out into the Great Plains. Beyond the permanently infested region the insect occurs at times in great numbers and in recent years has caused extensive damage. This area includes Minnesota, Iowa, Missouri, Kansas, Arkansas, Oklahoma and Texas. The eggs are laid in any kind of soil but preferably in bare sandy places in dry, rather compact ground. Meadows and pastures where the grass is closely eaten off are favorite places for egg laying. In localities where vegetation is scarce the eggs are frequently laid around the base of shrubs. The egg mass is usually placed about 1 inch below the surface. Young locusts, when migrating, are most active during the warm hours of the day and move in armies in the same general direction. The young travel at the rate of about 10 feet per minute. The adult winged locusts when migrating fly at different rates, according to the conditions of the locality, perhaps averaging about 20 miles a day. Extended flights are not observed until a few days after the locusts have acquired complete wings.

Much injury to cultivated crops which is commonly attributed to the Rocky Mountain locust is done by the various species of nonmigratory locusts which are always found in greater or less numbers in most localities. Occasionally the nonmigratory forms may multiply to such

an extent as to be exceedingly injurious. The habits of various species, except with regard to the matter of migration, are so similar that they need not be described for the individual species.

There are many remedies which have been devised for the destruction of these insects. One good remedy consists in scattering poisoned bait made of bran 400 pounds, middlings 15 pounds, syrup 2 gallons, arsenic 20 pounds, the whole being moistened with water. Lubricating oil has certain advantages over molasses in keeping the bran from drying up too soon. A formula used in Illinois contained bran 100 pounds, arsenic 4 pounds, and lubricating oil 2 gallons. Swarms of young locusts may be checked by spraying them with kerosene emulsion or by spraying the vegetation in front of them with Paris green or other arsenical poison. Where the young locusts are present in great numbers perhaps the best means for combating them is some form of hopperdozer. This apparatus usually consists of a strip of sheet iron 8 or 10 feet long, turned up about an inch in front and about a foot behind, so as to form a shallow vessel in which water may be kept, covered with a film of kerosene oil. The apparatus is mounted on wheels or runners and propelled by man or horses. The young grasshoppers spring into the air as the hopperdozer passes along and fall into the kerosene, where they are destroyed. The young locusts usually collect at night under grass or other substances which may serve as protection. This habit may be taken advantage of in destroying them. If dry straw is scattered over infested fields in early spring and burned at night or early in the morning, the young locusts which have collected under it will be destroyed. Deep fall plowing will cover the eggs so that a large number of the young locusts will be unable to reach the surface of the ground in the spring. In South America, South Africa and Australia good results have been obtained in fighting locusts by the use of a fungous disease. This disease has been imported into the United States and used with some success. The use of various tarred barriers, ditches supplemented with holes into which the young locusts fall, and irrigation ditches, has been recommended as means of checking the advance of an army of young locusts.

The females of some species congregate in the regular breeding grounds from the neighboring country to lay their eggs. The egg capsules contain 40 to 120 eggs each. A count of hopper eggs in Sevier Valley, Utah, showed 175 per spare inch, or 25,200 per square foot, or about 1 billion per acre. Account of the young wingless hoppers in another badly infested locality, indicated about 2 billion on an area of 320 acres. Utah was then paying a

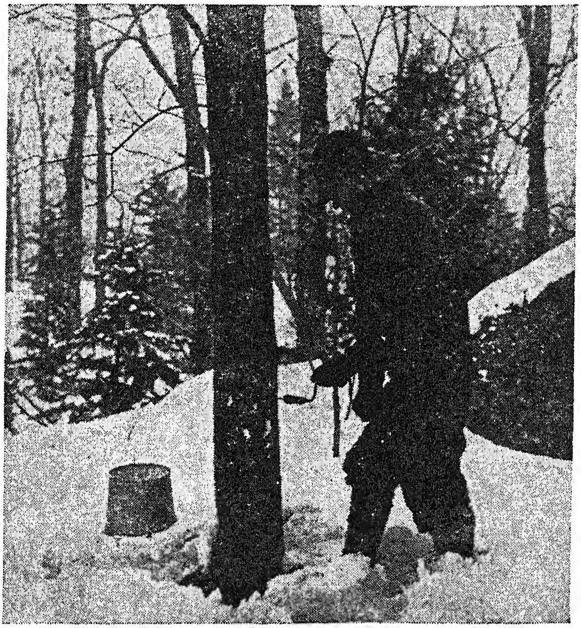
VERMONT MAPLE SUGAR BUSH

bounty of 50 cents a bushel for the hoppers, a bushel containing 250,000 hoppers.

MAPLE SUGAR

Maple sugar is obtained from a number of kinds of maple all of which have a sweet sap, but only the sugar maple (*Acer saccharum*) and a variety of that species are important. Even the box-elder sap yields sugar, but these trees are not found in sufficient number to make tapping profitable. The chief maple sugar States are Vermont, New York, Ohio, Pennsylvania, Michigan, Massachusetts, New Hampshire, Wisconsin, Maine and Maryland. Since 1920 the number of maple trees tapped has declined from 14 to 10 million and the total product in terms of sugar, from 33 million to 17 million pounds. The product per tree varies from year to year according to weather conditions, but averages about 2 pounds of sugar. The sugar content in the sap also varies from season to season and from tree to tree, depending somewhat on their age and size, from 1 to 4 per cent with an average of about 2 per cent.

In tapping maples it has been found desirable to use a sharp, clean bit ⅜ to ½ inch in diameter. The direction of the bit should be slightly upward into the tree and should be 1½ to 2 inches in depth, seldom deeper. The spot for boring the tap hole should be cleaned of loose bark, and should preferably be on the south or east side of the tree. Both wooden and metal spouts have been used, but metal spouts are preferable for cleanliness and strength. The sap bucket hanging from the spout should rest against the tree so that its weight is largely sustained by the bark of the tree without lacerating the young sap wood. "In driving spouts into the tree care must be taken not to compress the sapwood or rupture the bark. Both these mistakes prevent the flow of sap, and splitting the bark may lead to decay and injury to the tree."



TAPPING MAPLE TREE

The season for tapping is ordinarily February and March when the temperature rises above 32 degrees F. during the day, but goes to the freezing point at night. Thus there may be a flow of sap for a day or two followed by an interruption of a few days due to a cold snap. During the season there may be from 3 to 10 or more of these alternations. The first of the run is sweetest and of the best flavor. As soon as the buds start the color of the sugar is darker and the flavor ranker.

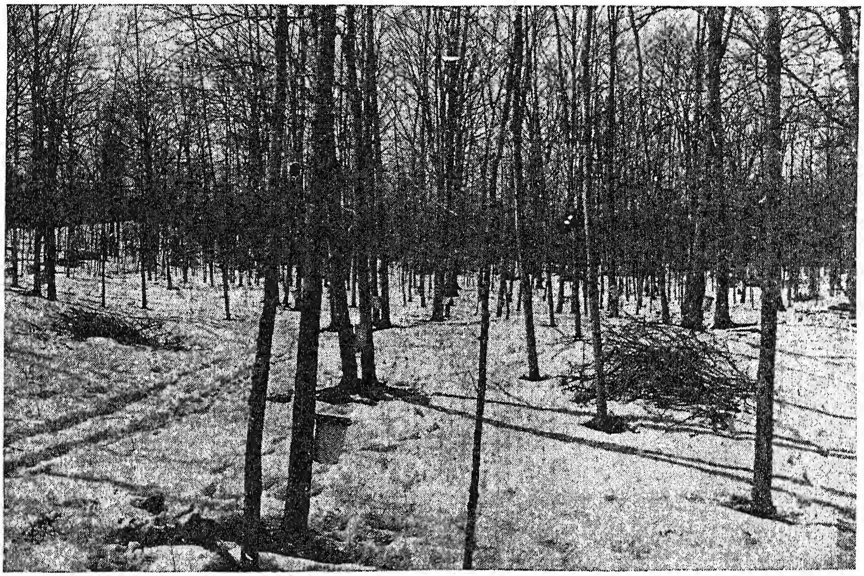
The length of the productive life of

maple trees cannot be stated with any assurance. It is held by some observers that the trees do not reach tapping age before 50 years and after they pass the age of 175 to 225 years they are no longer commercially profitable. Old patriarchs of this sort in a sugar grove, if of straight bole and well preserved, may be removed for lumber.

As between metal and wooden sap buckets the former are to be preferred, usually with covers. But some sugar makers feel that while the covers keep out falling bark, leaves and rain water, they require more time in emptying. Larger gathering buckets are used for transferring the sap to the wooden or metallic tank on the low horse-drawn sledge or stoneboat, for hauling to the boiling house. The sap is evaporated down to the consistency of syrup in large iron kettles, sheet iron or sheet tin pans 2 to 3 feet wide and 3 to 6 feet long, or in the arch evaporator or other still more elaborate apparatus. As stated by A. H. Bryan of the Department of Agriculture, "In commercial practice maple syrup should weigh not less than 11 pounds to the gallon. A syrup made thinner than this will sour, and one made much thicker will tend to crystallize. The proper density may be determined by inserting a hydrometer in the syrup at a temperature of 60 degrees F., when the hydrometer should float at the level of 35.6 degrees.

"The portion of the product which is destined to become sugar is boiled down to the sugar stage in large kettles or 'sugaring off' pans.

"From 5 to 40 gallons of sap is obtained from a tree during a season, on an average between 10 and 20 gallons. Normal sap of an average year contains about 2 per cent of sugar, although it may vary from 0.5 per cent to as high as 7 or even 10 per cent. The sugar content varies greatly with the tree, its location and its past growth. One tree can be counted on to give from 1 to 7 pounds of sugar per season, or, expressed in syrup of standard density, from 1 pint to 1 gallon, although the average from year to year and from tree to tree is about 3 pounds of sugar or 3 pints of syrup. In a normal year, then, 1 barrel of sap (32 gallons) should produce a gallon of syrup or 7½ pounds of sugar. In many camps and for many years it takes sometimes as much as 50 gallons of sap to make 1 gallon of syrup. First runs of sap are generally richer in sugar, and hence take less for a gallon of syrup. From 6½ to 9 pounds of sugar, according to the kind, can be made from 1 gallon of standard syrup, with an average of 7½ to 8 pounds. A camp of 100 trees should produce about 40 gallons of syrup or 300 pounds of sugar."



YOUNG MAPLE SUGAR BUSH

A study of the maple sugar industry in Garrett County, Maryland, by the Maryland Experiment Station, indicated that a grove should contain about 700 trees for efficient handling, and that there should be at least 30 producing trees per acre. In general maple sugar production seems to be on the wane. Fewer trees are being tapped as time goes on, and little interest is manifested in replacing old trees.

PIPING MAPLE SAP TO BOILER HOUSE

MOSQUITOES

Mosquitoes are small two-winged flies with long slender abdomen, a fringe of hair around the edge of the wings, and scales on the wing veins. The larval state of many, if not all, species of mosquitoes is passed in stagnant water of pools or swamps. The eggs are laid on the surface of the water, singly or in masses, and the larvae are the well-known "wigglers" of rain barrels and pools. The larvae of some species remain for a greater portion of the time at the surface of the water and wiggle downward when frightened. Other species come to the surface only occasionally to breathe.

Mosquitoes pass the winter in the adult state in cellars and other protected places, and as larvae in water. There are several generations per year, depending upon the climate of the locality. Mosquito larvae die within a few days in wet mud, if the pond dries up. Their transportation from place to place is considerably facilitated by winds and by animals to which they become attached. The male lives but a short time and ordinarily does not suck blood. The female normally feeds on the juices of plants, but attacks warm-blooded animals at every opportunity. In some localities mosquitoes are so numerous as to become a plague and cause the interruption of business for a few weeks in summer.

The common means of preventing mosquitoes from entering houses is through screening of windows. In houses they may be destroyed by fumigating with pyrethrum, or they may be caught on the walls by the use of shallow cups containing a small quantity of kerosene and mounted on a pole. The most effective remedies are draining the marshes, or, where this is impossible, covering all stagnant water with a film of kerosene. For this purpose 1 ounce of kerosene is required for each 15 square feet of surface. The oil film should be renewed every 10 days during the season. The larvae on coming to the surface for air are killed by contact with the kerosene. Potassium permanganate is occasionally recom-

mended in newspapers as a cheap and efficient remedy against mosquito larvae in water. Careful tests of this substance have shown that it is practically worthless.

Malaria is transmitted to man through the bite of certain mosquitoes. Of the several genera of these insects, *Anopheles* is apparently the only one concerned. It is recommended that stagnant water in the neighborhood of cities should be treated with kerosene. There are several kinds of *Anopheles* mosquito, carrying different forms of malaria, some of the tropical forms being much more virulent than common ague fever.

Yellow fever is also spread by a mosquito of the genus *Stegomyia*. The building of the Panama Canal was made possible by campaigns of eradication of mosquito breeding places.

A *Culex* mosquito is suspected of being a carrier of dengue fever.

POWER ON FARMS

In agriculture as in other industries there has been a trend, especially during the past 100 years toward replacing hand labor by animals, water, gasoline, steam or electric power. The U.S. Department of Agriculture many years ago illustrated this change in a table of statistics. It appears that in 1850 there were 1,701,000 oxen, 559,000 mules, and 4,337,000 horses kept as work animals on farms. In 1900 about 960,000 oxen, 2,753,000 mules, 15,506,000 horses, 600,000 windmills, 70,000 steam engines and 200,000 gas engines were at work on farms. In 1942 farmers were using 9,856,000 horses, 3,811,000 mules and 1,655,000 tractors in addition to automobiles, motor trucks, steam engines, gas engines, electric power, water power and windmills as well as a great variety of power driven machinery. Less than ⅕ the power used on farms today is furnished by horses and mules. In 1820 over 83 per cent of persons gainfully employed were engaged in agriculture. Now less then 21 per cent are on farms. In 1830 over 57 hours of man labor were required in producing 20 bushels of wheat. In 1930 only 3½ hours were needed. Not all farm operations can be mechanized to a like extent. Cotton, for example, still demands relatively more hand labor notwithstanding the promising motorized cotton pickers now under experiment. But man cannot compete with gasoline or steam power or even with horses as a mere source of physical power. It is estimated that one 1200-pound horse can develop as much power as eight 150-pound men. On that basis, if horse power is worth $1 an hour, man power would be valued at less than 13 cents an hour. Naturally mechanization of farm work is progressing as rapidly as suitable machinery can be devised. The average farm worker now directs the operation of over 7 horse power of energy. He will have more power at his service as time goes on.

From 1920 to 1940 the number of tractors on Ohio farms increased 9 times, while the number of horses was reduced about half. It was found that tractors were cheaper than horses on farms of 60 acres or more, and that the cost of fuel and oil was usually less than the value of horse feed. Horses, however, are still an important source of power on 80 per cent of our farms. Relatively few farmers dispense with horses entirely after buying a tractor. The 13,600,000 horses and mules find many farm chores to do notwithstanding the 3,650,000 motor cars, the 864,000 trucks, the 257,000 electric motors and the 945,000 stationary gas engines in use on farms.

RABBITS

Considerable interest attaches to rabbits and hares especially on account of the great damage which they may commit upon cultivated crops, and on account of the profits which may be secured under favorable conditions from the breeding of some races, especially the Belgian hare. Rabbits and hares are universally hunted for game and their meat is generally considered a delicacy. But unhealthy rabbits must be shunned on account of the often fatal disease tularemia, easily transmitted to man. In localities where the animals have bred in the wild state to such an extent as to become an agricultural nuisance they have to be killed and their meat used in canning and for other purposes. Large shipments are annually made from Australia, where rabbits have perhaps become the most serious pests, and from California, Colorado and other Western States, where the jack-rabbit has multiplied in large numbers.

Perhaps the most serious injury is done by rabbits in gnawing the bark of fruit trees in winter. When other food is scarce rabbits may destroy whole young orchards by girdling the trees. Various methods have been adopted for the extermination of rabbits in such localities, and for the protection of fruit trees against their attacks. The methods employed for this

purpose include hunting with firearms or with ferrets, trapping, asphyxiation with gases in their burrows and driving into corrals by means of regularly organized parties of mounted hunters. The latter method has proved most successful in California, Oregon, Utah, Idaho and Colorado, where hundreds of thousands of jack-rabbits have been captured in this manner. As many as 20,000 have been captured in a single drive. The attempt to destroy rabbits by spreading contagious disease among them has thus far not proved very successful. The use of poisons, such as strychnin and phosphorus has certain disadvantages, on account of the fact that the jack-rabbits do not burrow, and consequently the poison must be scattered on the surface of the ground and be a source of danger to other animals. The protection of fruit trees and vineyards against rabbits may be accomplished by means of rabbit-proof fences made of woven wire, or by special cylinder protectors for each tree or grapevine. Young trees and grapevines may be protected by wrapping them with strips of burlap, gunny sacking, coarse cloth, wire netting, pasteboard, ordinary newspapers or by means of "tule-tree protector" or cylinders made of yucca wood. The last two named protectors are especially made for this purpose. Newspapers wrapped around the trees and fastened by a cord not too tightly serve as good protectors against rabbits and mice. Some orchardists have been successful in protecting their trees against attacks of rabbits by smearing the trunks near the ground with mixtures which are distasteful to rabbits. For this purpose whitewash, a mixture of glue and copperas, decoction of quassia chips and blood or grease, have been used. Mechanical protection by means of some wrapping is more permanent and effective than any form of wash.

Where jack-rabbits multiply in unusual numbers they may do serious damage to cultivated crops, particularly alfalfa. The rabbits emerge from their hiding places in sage-brush at dusk and consume and trample down large areas of alfalfa and other succulent crops. In Arizona it has been calculated that 15 jack-rabbits will eat as much as one sheep.

In the Eastern States the common rabbit is sometimes injurious to fruit trees, and orchards may be protected in the same way as recommended for jack-rabbits.

The natural enemies of rabbits help to prevent their increase in numbers. The most important of such enemies are hawks, owls, foxes, coyotes and weasels.

Belgian Hares. The Belgian hare has been claimed by some authorities to be a cross between the rabbit and hare. Mr. J. E. Harting asserts, however, that the Belgian hare or leporine is simply a large domesticated variety of the common rabbit, resembling the brown hare in form and color. The same authority states that this race of animals originated about 45 years ago in Belgium as a variety of the rabbit, and has since been reared extensively for the purpose of increasing its size and of producing the form, color and fur of the wild hare. The fur of the back next to the skin is dark colored, instead of being light, as in the case of the common brown hare. Their fore legs are much shorter than the latter. The standard of the Belgian hare's appearance, as adopted at present, requires that the color should be a rich reddish-brown, with as little white as possible under the jaws. The body should be long, with well tucked up flanks. The tail should be straight, the ears about 5 inches long and thin, the eye large and of a hazel color, the fore feet and legs long and slender and free from white hairs. The weight should be about 8 pounds. The short, arched appearance of the back common in the rabbit is considered a defect in the Belgian hare.

Much interest has been recently developed in the breeding of these animals, and many persons in different parts of the country have gone into the business for profit. While good prices were obtained by special breeders for standard animals for breeding purposes, it must be admitted that there is no large natural demand for the meat of these animals, and persons who engage in this business with the expectation of making large profits are apt to be disappointed.

RATS

The common brown rat has become distributed throughout the civilized world by means of shipping and other methods of commercial transportation. The brown rat attacks all sorts of crops and grains, stored vegetables and animal products. It is also an enemy of poultry, and has been known to attack young pigs and lambs. Special interest has lately been developed in the destruction of these animals on account of their agency in distributing various infectious diseases. Their habit of eating any kind of decaying flesh or refuse makes it apparent that they may become one of the chief sources of spreading any contagious plague of man or animals. In

the vicinity of slaughter houses they are not only a disgusting nuisance, but serve to spread the infestation of trichina. In some cities where they have become an intolerable nuisance, especially in European countries, they have been successfully combated by spreading among them contagious diseases which do not affect man or other animals. Besides this method of exterminating them, the use of traps of various design, poisoned bait, hunting with ferrets, and asphyxiation with bisulphid of carbon in the burrows have been employed with success. Similar methods of extermination have also been used with success in combating the common house mouse and field mice or moles.

Rats are today one of our most dangerous pests. Whatever new diseases airplanes, and soldiers returning from all parts of the earth, may bring to us are likely to be distributed hither and yon by rats. In many localities, even in the most densely populated parts of cities, rats are so numerous that organized community efforts will be needed to subdue them.

Rats breed in geometric progressions, 6 to 8 litters annually of 6 to 20 young per litter, or monthly in warm climates. One pair of rats might become the ancestors of 350 million progeny in 3 years. On farms rat-proof buildings is the permanent way of safe-guarding farm products, or by using poison bait containing barium carbonate, red squill, phosphorus or thallium.

RURAL HEALTH

The problems of health, sanitation, medical service and prevalence of disease on farms differ in several ways from those of large cities. Typhoid, pellagra, dysentery, hook worm and malaria are far more prevalent in rural than in urban communities, while scarlet fever, diphtheria, puerperal septicemia and measles are more rampant in cities. The home water supply on farms is subject to many sources of contamination and must be kept under close watch. Even the most crystal pure spring is not beyond suspicion unless protected against all chance of unsanitary environment. The pet family cow must be occasionally tested for the possible presence of brucellosis or tuberculosis. There have been as many as 9 million cases of malaria annually in the U.S. Now that the Japanese have control of quinine supplies we must depend upon the synthetic drug atabrine for the cure of malaria. Meanwhile clean-up campaigns in the breeding places of malarial mosquitoes are showing results.

Vigorous health depends in part upon eating an adequate diet of the right sort and variety. The family cow, a flock of hens, and the home garden, together with home-butchered meat, and gleanings from an orchard should provide an array and variety of food beyond the criticism of the strictest dietician. But the home garden is not always cared for as it should be.

Then there is a universal tendency among physicians to abandon the rural districts in favor of the cities. Those who remain belong mostly to the older generation. The old-fashioned country doctor was perhaps the most vitally important person in the rural community. He was a general practitioner, a naturally shrewd judge of character and a good diagnostician. Good country roads and automobiles have greatly shortened the time required in visiting farm patients, and telephones often obviate the necessity of making calls, but there is still a demand for more doctors of the general practitioner type to meet the needs of rural medical service.

SEED

Four rules of great importance in securing good seed have been laid down by writers on this subject. There are: (1) Buy only of reliable seedsmen, (2) buy the best grade of seed, (3) insist upon a statement of the percentage of seed which will germinate, and (4) test the seed yourself. Poor and cheap grades of seed are really more costly than the best and highest priced. According to actual tests unclean seed may contain 20,000,000 or more weed seed per bushel. Moreover, poor seed may contain such a small percentage of germinable seed that a thin stand of the crop is obtained. It may be necessary to buy 5 or 6 bushels of low grade seed in order to secure as much germinable seed as is contained in one bushel of good seed. The farmer will save time, money and labor by buying the best quality of seed. At the same time he will avoid seeding his farm to all kinds of weeds.

A guaranty of the quality of seed should be demanded from the seedsman, and their claim may easily be substantiated or disproved by a germination test. For this purpose a piece of blotting paper or flannel cloth may be moistened and folded together after placing a counted number, say 100, of seed between the folds. The paper or cloth should then be laid on a plate, covered with another inverted plate and placed in a warm room. From 10 to 28 days should be allowed for the test, according to the kind of seed. The ger-

minated seed may be counted and removed from day to day, and at the end of the test the percentage of good seed may be easily computed. The standard of germination adopted by the United States Department of Agriculture for clean seed, harvested and preserved under favorable conditions and not over one year old, is for a number of vegetables as follows: beans, 90 per cent; beets, 142 plants from 100 seed balls; cabbage, 90 per cent; carrots, 80; cauliflower, 80; celery, 60; corn, flint and sugar, 87; cucumber, 87; eggplant, 80; leek, 80; lettuce, 85; muskmelon, 87; okra, 80; onion, 80; parsley, 70; parsnip, 70; peas, 93; peppers, 80; pumpkin, 87; radish, 90; spinach, 84; squash, 87; tomatoes, 85; turnips, 90; and watermelons, 87 per cent. These figures are based on results secured in a seedtesting apparatus where the conditions of temperature and moisture could be controlled. When seed is tested in soil the germinations are likely to be 10 or 15 per cent lower than these figures.

As to relative value of new seed and those 2 years old or more, it may be stated in a general way that fresh seed give the best results, but there are some exceptions. Experienced cabbage growers claim that cabbage seed 2 or 3 years old make better and more solid heads than 1-year-old seed.

The Experiment Station in Vermont, as in many other States, makes an annual report on the results of inspection of agricultural seeds sold within the State. In the majority of samples the seed have proved to be as represented in purity and germination. Mail order shipments are not subject to inspection and may be weedy and of low germination. Grass seed mixtures have been found difficult to sample accurately for the reason that heavy seed like clover slip down to the bottom of the bag while chaffy grass seeds remain at the top.

Another seed problem worth bearing in mind is the fact that several serious diseases of vegetables are carried in the seed. Such may be the case with the seed of beans, cabbage, cauliflower, celery, cucumber, eggplant, melon, peas, radish, pepper, turnip, tomato and watermelon. If the farmer saves his own seed he should have care not to select seed from diseased plants. In any event it is well to treat the seed as recommended under the individual crops and under spraying.

TOADS

These animals, because of their somewhat repulsive appearance, are persecuted to a considerable extent, and are often destroyed in large numbers by small boys. The toad, however, is a valuable friend to the greenhouse owner or gardener, and assists greatly in the destruction of common injurious insects in such localities. Their food consists almost exclusively of insects, slugs, worms and spiders. Insects constitute their chief element of diet, all sorts of insects, including beetles, cockroaches, plant bugs and caterpillars, being devoured greedily by the toad. It is desirable to protect all toads in the vicinity of gardens and in greenhouses. Their humble services are well worth that much consideration.

WEEDS

Weeds are plants out of place or growing where we do not want them. They may be annuals, biennials or perennials. They belong to a great variety of botanical families, varying in their habit of growth from prostrate creeping plants to long climbing vines, from delicate herbs to woody shrubs, from innocently smooth and succulent species relished by poultry and farm animals to bristly, spiny, burbearing, inedible or poisonous plants. Some of them are local in distribution, or only occasionally troublesome, while others are aggressive and occur everywhere. Some are easily gotten rid of while others offer great difficulties in eradication. Nearly every State has published lists of weeds, and hundreds of general descriptive works have been published with good illustrations of the various weeds, as for example a recent bulletin from Colorado. It would require several hundred pages to describe them all. Those interested in that phase of the subject may readily get the desired information from their Experiment Station. Most farmers' interest in weeds is concerned with how to get rid of them. The U.S. Chamber of Commerce recently estimated that the yearly loss caused by weeds in the U.S. is about 3 billion dollars.

Weeds may do harm in several ways, particularly by diminishing the crop yield by removing water and plant food from the soil, by lowering the value of farm products such as hay and grains through the admixture of worthless seeds and other material, by increasing the cost of farm operations, by harboring diseases and insect pests which may more easily attack cultivated crops or by poisoning live stock. Weeds may reach a farm in one or more of many ways. The seeds of many plants, such as beggar ticks, burdock or cocklebur, have hooks by means

of which they may be carried in the fur of animals, or the seeds may pass through the digestive tract of animals in a condition ready for prompt growth, or may be carried on the feet of birds. Winds may carry thistle and similar seeds hundreds of miles. The Russian thistle is rolled along on the ground by winds and piled up in fence rows. Irrigation canals and streams may carry weed seeds indefinitely far. Seeds of various kinds of weeds may gain access to a farm in hay, grain, nursery stock, packing materials brought in from other localities, or may be carried in by autos, trucks, railroads or airplanes. Unkempt roadsides, or railway rights of way, neglected fence rows or waste fields are excellent lurking places for weeds ready to invade the crop fields.

Moreover, many weeds produce seeds capable of retaining their viability for 5 to 40 years or more. Striking examples of this phenomenon may be seen in arid regions where after heavy rains certain species suddenly spring up which had not been seen there for several years. The rapid spread of weeds is partly accounted for by their great vigor and abundant seed production. A single tumble-weed may develop 120,000 seed or a pigweed may produce 115,000 seed.

But while weeds are legion, hardy, aggressive and quite capable of taking complete possession of a farm if nothing is done about them, there are practical means of controlling them, and a clean, weedless farm is a badge of good farming, while a farm overrun by weeds proclaims a careless or indolent farmer.

Prevention of the introduction of weeds is the first point to which attention should be directed. Each one of the several ways by which weeds smuggle themselves into a farm, as already mentioned, should be carefully watched, and perhaps the first gateway to guard is the seed supply bought for farm use. That is one of the most common and prolific sources of weed seeds. As reported by the Colorado Experiment Station "of over 200 samples of alfalfa seed collected directly from dealers, only 20 per cent were found to be free from noxious weeds. Fifty per cent averaged 36 noxious weed seed per pound. The remaining 30 per cent contained an average of 367 weed seeds per pound." Thus it appears that the safest way to insure against planting weeds is to have all seed tested before planting, or to insist on seed guaranteed by a reputable dealer or by the State Seed Registration Service.

There is no royal road to the destruction of weeds. These plants thrive best in waste places, along roadsides and on poorly cultivated land. Where the soil is properly tilled and attention is given to a suitable rotation of crops, weeds are of little consequence. The possibility of a luxuriant growth of weeds simply furnishes an urgent reason for thorough tillage of the soil, and the result is seen in better crops of cultivated plants.

In gardens, cultivation and hand pulling are the sovereign remedies for weeds. In lawns, annual weeds may be destroyed by repeated mowing. Perennial weeds may be eradicated by digging and pulling and by sowing more and better grass seed. Weeds in grass lands are to be crowded out by securing a thick sod. If the grass seed is impure and the stand of grass is poor it may become necessary to plow and reseed. In cereal and other field crops the use of horse-power weeders has been attended with good results. Where a rational rotation of crops is followed, weeds seldom obtain a foothold. Special attention should always be given to waste places and roadsides in order to prevent weeds from going to seed in such localities. A number of States have passed laws making this compulsory. In many part of the country, especially in the Western States, where grains volunteer very readily, summer fallowing is practiced partly for the purpose of keeping down the weeds. If, however, the soil is not persistently cultivated, this practice simply gives the weeds an opportunity to develop unrestricted. Many weeds may be destroyed by repeated cutting before the seeds have become mature. If, for example, the oxeye daisy is cut within 10 days after blooming it will be prevented from seeding.

Weed burners or torches have been much advertised but may destroy only the seeds and above-ground parts, leaving the roots unharmed. Fallowing, if conscientiously followed, may be effective, but if only half done may merely give the weeds a monopoly of the field. Smother crops are helpful in many situations. Buckwheat is notorious as a smotherer of weeds. Lawns badly infested with crab grass and other weeds may be cleaned up by plowing and planting to cowpeas for one season. Crab grass being an annual may be cleared out of lawns by hand pulling of the young crab grass plants about July 1 or before they have gone to seed. Fall wheat and rye are also effective as smother crops, as well as alfalfa, Sudan grass or sorghum. Some weeds may be controlled by mowing so often that they are unable to produce seed. Under proper control, sheep, hogs and poultry are weed

eradicators. Ducks are fond of dandelions and are quite widely used to eradicate that weed in lawns.

Much interest has centered in recent years in chemical weed killers. At the Rhode Island Station it was found that common sorrel could be gradually driven out of acid soils by liming. Lime increases the yield of timothy, orchard grass, brome grass or clover, but greatly checks the growth of sorrel. This may be accomplished by applying 5 tons of air-slaked lime per acre, followed by an application of 3 tons per acre during the next year. In North Dakota it was found that nearly all the annual weeds commonly found in grain fields could be killed by spraying with copper sulphate without injuring the grain. About 1 barrel (30 to 60 gallons) of a solution of copper sulphate in the proportion of 1 pound to 4 gallons of water is required per acre. This application is not effective in dry weather. Spraying should be done when the young weeds are just out of the ground, while the grain stands from 5 to 10 inches high. Experiments in Vermont showed that the various species of wild mustard could be cheaply destroyed in this manner. Sodium chlorate is probably the most generally used herbicide. But the amount of chemical required may make the cost prohibitive. Three to 6 pounds per square rod have been found necessary. Any material, such as floors of buildings, trucks or wagons, upon which the solution is spilled is rendered highly, almost explosively, combustible. Common salt may be used on paths or driveways but is too expensive for wide use.

Sodium arsenite has been used as a spray for killing weeds in California, on sugar plantations in Hawaii and elsewhere. For destroying annuals a spray made by adding 1 gallon of the commercial solution of sodium arsenite to 50 gallons of water has been used. Too long continued use of this spray may result in a concentration of arsenic in the top inch of soil. For notwithstanding that in the spray the arsenic is in solution, the arsenic is fixed in an insoluble form in the soil. Carbon bisulphide has been tried as a freezing agent to destroy certain shrubby weeds but is costly, illsmelling, inflammable and causes violent headache if the fumes are inhaled. Iron sulphate in a solution containing 100 pounds iron sulphate in 50 gallons has been used on lawns for dandelions, on grain fields against wild mustard and under other conditions. Such use in Hawaii led to the discovery that the iron sulphate spray applied to pineapples is a complete and rapid cure for the yellowing of pineapples on highly manganese soils. For controling dandelions in lawns ammonium sulphate has also been recommended. In Illinois sodium chlorate is preferred in the eradication of field bind weed. But despite the wide advertising and considerable vogue of chemical weed killers, they can hardly be said to replace the old familiar methods of hand pulling, hoeing, use of cultivators and horse-drawn weeders, clean culture, mowing and suitable crop rotation. Where Johnson grass has become thoroughly established, as is the case in many localities in the South, "instead of trying to eradicate it by laborious and expensive methods on areas on which it is very abundant, it may be more profitable to utilize the plant as a hay crop in rotation with corn, as has been done in several parts of the Cotton Belt."

There are many weeds which are poisonous to stock and have caused heavy losses in sheep, cattle and horses, particularly in the Western States. In this group of weeds perhaps 25 to 30 species are important, among which death camas, loco, larkspur, aconite and whorled milkweed are most familiar.

All species of death camas are poisonous especially to sheep, cattle and horses. They are erect, low growing members of the lily family and are found from Kansas to the Pacific Coast. No practical remedy has been found. Dependence must be placed on avoiding the areas where the plants grow, at least during the season when they are succulent and palatable.

Loco weeds affect chiefly horses. The Spanish word loco, meaning crazy, was applied to the plant on account of the strange nervous behavior of affected horses. There are several species of loco, the white and purple being perhaps the best known, and are largely distributed from Texas to Alberta on the uncultivated range lands. These plants are legumes, as may be readily recognized by their blossoms. Losses from loco are not as great as might be supposed from the volume of literature which has been published about them. There is no specific remedy for locoed horses. When the first symptoms of unsteady gait appear, affected horses should be taken off the range where loco weeds grow and fed in a corral or some pasture free from loco.

SOURCES OF INFORMATION

Location of State Agricultural Experiment Stations

In the following list the location of the Agricultural College and Agricultural Experiment Stations is given for each State and Territory. In a few cases there are two Experiment Stations in the same State. Otherwise the Experiment Station and College are in the same town. For bulletins and technical advice requests should be sent to the Director of the Agricultural Experiment Station of your State, or to the Director of Extension of the College.

ALABAMA—Auburn.
ALASKA—College.
ARIZONA—Tucson.
ARKANSAS—Fayetteville.
CALIFORNIA—Berkeley.
COLORADO—Fort Collins.
CONNECTICUT—(State station), New Haven. (Storrs station), Storrs.
DELAWARE—Newark.
FLORIDA—Gainesville.
GEORGIA—(State station), Experiment.
HAWAII—Honolulu.
IDAHO—Moscow.
ILLINOIS—Urbana.
INDIANA—LaFayette.
IOWA—Ames.
KANSAS—Manhattan.
KENTUCKY—Lexington.
LOUISIANA—University Station, Baton Rouge.
MAINE—Orono.
MARYLAND—College Park.
MASSACHUSETTS—Amherst.
MICHIGAN—East Lansing.
MINNESOTA—University Farm, St. Paul.
MISSISSIPPI—State College.
MISSOURI—(College station), Columbia.
MONTANA—Bozeman.
NEBRASKA—Lincoln.
NEVADA—Reno.
NEW HAMPSHIRE—Durham.
NEW JERSEY—New Brunswick.
NEW MEXICO—State College.
NEW YORK—(State station), Geneva. (Cornell station), Ithaca.
NORTH CAROLINA—State College Station, Raleigh.
NORTH DAKOTA—State College Station, Fargo.
OHIO—Wooster.
OKLAHOMA—Stillwater.
OREGON—Corvallis.
PENNSYLVANIA—State College.
PUERTO RICO—(Federal station), Mayaguez. (College station), Rio Piedras.
RHODE ISLAND—Kingston.
SOUTH CAROLINA—Clemson.
SOUTH DAKOTA—Brookings.
TENNESSEE—Knoxville.
TEXAS—College Station.
UTAH—Logan.
VERMONT—Burlington.
VIRGINIA—(College station), Blacksburg. (Truck station), Norfolk.
WASHINGTON—(College station), Pullman. Western Wash. Expt. station), Puyallup.
WEST VIRGINIA—Morgantown.
WISCONSIN—Madison.
WYOMING—Laramie.

BUREAUS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

Inquiries addressed to the United States Department of Agriculture, Washington, D. C. may be directed to the Secretary of Agriculture, or to any of the Divisions. Some of the more important ones to the vegetable grower are:

Office of Information
Bureau of Plant Industry
Bureau of Entomology and Plant Quarantine
Bureau of Agricultural Economics
Bureau of Chemistry and Soils
Weather Bureau
Soil Conservation Service

Farmers bulletins are issued by the United States Department of Agriculture. They cover a wide range of subject matter and are of interest to a great many groups of persons. They are written in popular language easily understood by the layman. These may be obtained through your United States Senator or the representative from your district or from the Department of Agriculture, Washington, D. C. direct.

TEXT AND REFERENCE BOOKS

In equipping for the business of farming a small reference library should be considered as essential as the machinery. It is especially important that the young farmer be started right, just as it is important that every man who has been farming for years should keep up with the procession of agricultural advance and change and adapt his farm practice to the new discoveries of science. No attempt is made here to present a definitive bibliography of rural books now in print. The list is too extensive and many pages would be consumed and nobody would be much benefited. The following is a list of standard books that are recommended as extremely valuable and helpful to all people either now engaged or soon to engage in farming. There is no investment that will pay such big returns as a select book that will give you just the information that you need just when you want it.

BOOKS

General

Bailey, L. H., Standard Cyclopedia of Horticulture, 3 volumes	$15.00
Bonert, J., Soldering (Workshop, Farm and Home)	1.25
Davidson, J. B., Agricultural Machinery	3.50
Felt, E. P., Shelter Trees in War and Peace	2.50
Felt, E. P., Our Shade Trees	2.00
Felt, E. P., Pruning Trees and Shrubs	2.00
Hopkins, J. A., Elements of Farm Management	2.20
Kains and McQuesten, Propagation of Plants	3.50
Laurie and Chadwick, The Modern Nursery	5.00
Nadler, M., Modern Agricultural Mathematics	2.00
Nissley, C. H., Starting Early Vegetable and Flowerings Plants Under Glass	3.25
Post, Kenneth, Plants and Flowers in the Home	2.00
Stone, A. A., Farm Tractors	3.75
Tornborgh, B. V., The Farm Bookkeeper	2.00
Whitman, R. B., First Aid for the Ailing House	2.50
Watts, Gilbert H., Roadside Marketing	1.25
Wilcox, E. V., Modern Farmers' Cyclopedia of Agriculture	5.00
Wright, W. J., Greenhouse Construction	2.00

Vegetable Growing

Bouquet, A. G. B., Cauliflower and Broccoli Culture	1.25
Clarkson, R. E., Herbs	2.75
Cruess, W. V., Commercial Fruit and Vegetable Products	6.00
Lloyd, J. W., Muskmelon Production	1.25
Thompson, C., Sweet Potato Production and Handling	1.25
Thompson, H. C., Asparagus Production	1.25
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APPENDIX

PLANTING GUIDE

Crop	Hardiness	Time to sow * Hotbed or Planthouse	Time to sow * Outdoor Plant-bed	Sow or plant in field *	Inches Between rows	Inches apart in row	Inches deep to plant	Days seed to harvest
Asparagus, seed	V. Hardy		April		18-30	3-6	1	4 Yrs.
roots				April	36-60	18-24	6-10	3 Yrs.
Beans—Bush	Tender			5/1-8/1	24-36	2-4	1-2	40-70
Beans—Pole	Tender			5/15-6/15	36-48	6 (Hills 48)	1-2	60-90
Beans—Lima	V. Tender			5/15-6/15	30-48	6 (Hills 48)	1-1½	75-120
Beet	Hardy	2/1-3/1		4/1-8/1	12-30	1½-3	½	45-70
Broccoli	Hardy	2/1-3/1	4/1-6/10	4/15-7/15	24-36	18-24	½	65-100
Brussels Sprouts	Hardy		5/1-6/1	6/15-7/15	24-36	18-24	½	90-120
Cabbage*	Hardy	2/1-3/1	4/15-6/1	4/1-7/1	24-36	14-24	¼-½	60-120
Chinese Cabbage	Hardy			7/1-8/1	18-24	14-20	¼-½	70-90
Carrot	Hardy			4/1-7/1	12-24	1-3	½	60-120
Cauliflower	Hardy	2/1-3/1	5/1-6/10	4/15-7/15	24-36	18-24	¼-½	75-120
Celery	Hardy	2/15-3/15	5/1-5/15	5/1-8/1	24-48	4-8	⅛	120-180
Corn—Sweet	Tender	4/15		5/1-6/20	30-42	10-18	¾-1½	60-100
Cucumber	Tender	4/1-5/1		5/1-7/1	48-72	24-48	½-1	60-80
Dandelion	V. Hardy			4/1-9/1	18-24	6-10	¼	175-210
Eggplant	V. Tender	3/1-4/1		5/15-6/1	30-48	24-30	¼-½	100-150
Endive	Hardy			6/1-8/1	12-24	10-15	¼-½	80-100
Kale	V. Hardy			4/1-8/1	13-30	6-12	½	55-70
Kohlrabi	Hardy			4/1-8/15	18-30	4-8	½	55-70
Leek	Hardy		4/1-5/1	4/1-5/1	18-24	4-6	½	Winter
Lettuce	Hardy	2/15-3/15		4/1-7/20	12-24	10-15	¼	45-85
Muskmelon	V. Tender	4/1-5/1		5/10-6/1	48-84	24 (Hills 48)	½-1	85-95
Onion Seed	Hardy	1/15-2/1		4/1-5/1	12-24	1-3	½-¾	100-150
Onion Sets	Hardy			4/1-5/1	12-24	2-3	1	40-100
Parsley	Hardy			4/1-6/1	12-24	6-12	¼	90
Parsnip	Hardy			4/15-5/15	18-30	4-6	¼-½	Winter
Peas	Hardy			4/1-5/1	24-48	1-2	1-2	60-80
Pepper	Tender	3/1-4/1		5/15-6/1	24-36	18-24	½	90-150
Potato	Semi Hardy			4/15-6/15	30-36	8-14	3-4	80-130
Pumpkin	Tender			5/15-6/1	84-96	72-96	1	90-120
Radish	Hardy			4/1-9/1	10-15	1-2	½	25-40
Rhubarb	Hardy			Apr. and Oct.	33-60	24-48		1-2 Yrs.
Rutabaga	Hardy			6/15-7/15	18-30	4-6	½	80-110
Salsify	Hardy			4/15-5/15	18-30	2-4	½	Winter
Spinach	Hardy			4/1-9/15	12-24	3-6	½	40-60
Spinach N. Z.	Tender			4/15-5/1	36-48	24-30	1	60-90
Squash—Bush	Tender	4/1-5/1		5/15-6/1	48-60	33-54	1	55-65
Squash—Winter	Tender			5/15-6/1	84-120	72-96	1	80-120
Sweet Potato	Tender	4/1-4/14		5/15-6/15	48-72	12-24		100-150
Swiss Chard	Hardy			4/15-5/15	18-30	6-10	½	50-60
Tomato	Tender	3/1-4/1		5/15-6/1	36-60	36-48	¼-½	100-120
Turnip	Hardy			Apr. and Aug.	18-24	2-4	½	50-80
Watermelon	V. Tender	4/1-5/1		5/20-6/1	72-120	60-96	1	80-120

* For localities with last frost about May 15th to 20th.

QUANTITIES OF SEEDS REQUIRED

Crop	Quantity of seed: To plant an acre	Quantity of seed: To plant 100 ft. row	Quantity of seed: For given no. plants	Approx. no. of seeds per oz.	Average life years	Av. % strong germination 1 year
Asparagus	4 lbs.	1 oz.	1 lb. to 12000	1250	3	80
Beans—Bush	60 lbs.	1 lb.	—	60-80	3	85
Beans—Pole	30 lbs.	½ lb.	—	60-80	3	85
Beet	8-10 lbs.	1 oz.	1 oz. to 2000	1500	4	70
Broccoli	3 oz.	¼ oz.	1 oz. to 5000	10500	4	80
Brussels Sprouts	4 oz.	¼ oz.	1 oz. to 4000	6500	4	75
Cabbage	4 oz.	¼ oz.	1 oz. to 4000	8500	4	80
Chinese Cabbage	4 oz.	¼ oz.	1 oz. to 3000	7000	4	80
Carrot	2-4 lbs.	½ oz.	—	27000	3	70
Cauliflower	4 oz.	¼ oz.	1 oz. to 3000	10500	4	75
Celery	4 oz.	¼ oz.	1 oz. to 8000	75000	3	65
Corn—Sweet	8-12 lbs.	4 oz.	—	125-220	3	85
Cucumber	2 lbs.	½ oz.	1 oz. to 100 Hill	1000	5	80
Dandelion	5-6 lbs.	½ oz.	—	35000	4	75
Eggplant	6 oz.	—	1 oz. to 2000	6000	5	65
Endive	4-5 lbs.	½ oz.	1 oz. to 7500	15000	5	75
Kale	4-5 lbs.	½ oz.	—	7500	4	75
Kohl Rabi	4-5 lbs.	½ oz.	—	8000	3	80
Leek	4-5 lbs.	½ oz.	—	9000	2	80
Lettuce	3-4 lbs.	¼ oz.	1 oz. to 8000	16000	5	80
Muskmelon	2-3 lbs.	½ oz.	1 oz. to 50 Hill	1200	5	80
Onion Seed	4-5 lbs.	½ oz.	1 oz. to 6000	12000	2	75
Onion Sets	300 lbs.	2 lb.	—	—	—	—
Parsley	3-4 lbs.	½ oz.	—	17500	1	65
Parsnip	3-4 lbs.	½ oz.	—	6000	1	65
Pea	90-180 lbs.	1 lb.	—	60-120	3	85
Pepper	8 oz.	½ oz.	1 oz. to 1250	4000	2	65
Pumpkin	3-5 lbs.	1 oz.	¾ lb. to 100 Hill	100	4	80
Radish	8-12 lb.	1 oz.	—	3500	4	85
Rutabaga	1-3 lb.	½ oz.	—	10000	4	85
Salsify	6-8 lbs.	1 oz.	—	4000	1	75
Spinach	8-12 lb. Rows 20-30 Broadcast	1 oz.	—	3000	3	70
Spinach—N. Zealand	15 lb.	2 oz.	—	350	3	70
Squash—Bush	3-5 lb.	1 oz.	¼ lb. to 100 Hill	400	4	80
Squash—Winter	2-3 lb.	2 oz.	½ lb. to 100 Hill	125	4	80
Swiss Chard	3-5 lb.	½ oz.	—	1100	4	70
Tomato	2-4 oz.	¼ oz.	1 oz. to 3000	8000	4	80
Turnip	1-2 lb.	½ oz.	—	12000	4	85
Watermelon	3-4 lb.	1 oz.	—	150-200	5	80

A half more or less seed may be required for different conditions. *** In growing plants of cabbage or other cole crops in outdoor beds, allow about 8 ounces of seed for each acre of the crop. Seed treatments are described p. 22.**

NUMBER OF CROP SEEDS PER UNIT OF WEIGHT

Kind of seed	Approximate number of seeds per gram [1]	Minimum weight for purity analyses (grams)	Approximate number of seeds in working sample
Alfalfa	500	5	2,500
Barley	30	100	3,000
Beet	54	50	2,700
Bent grass	18,000	1	18,000
Bermuda grass	3,940	1	3,940
Blue grass, Canada	5,500	1	5,500
Blue grass, Kentucky	4,800	1	4,800
Brome grass, awnless	300	10	3,000
Buckwheat	45	50	2,250
Carrot	900	2	1,800
Clover, alsike	1,500	2	3,000
Clover, crimson	330	10	3,300
Clover, red	600	5	3,000
Clover, sweet	570	5	2,850
Clover, white	1,500	2	3,000
Crested dog's-tail	1,900	2	3,800
Fescue, meadow	500	5	2,500
Fescue, red	1,200	2	2,400
Fescue, sheep	1,500	2	3,000
Fescue, hard	1,250	2	2,500
Flax	300	10	3,000
Meadow foxtail	1,200	2	2,400
Meadow grass, rough-stalked	5,600	1	5,600
Millet, foxtail	470	5	2,350
Millet, proso	180	25	4,500
Oats	28	100	2,800
Orchard grass	1,150	2	2,300
Rape, winter	230	10	2,300
Redtop	11,000	1	11,000
Rye	40	100	4,000
Rye grass, Italian	500	5	2,500
Rye grass, English	500	5	2,500
Rye grass, short-seeded	700	5	3,500
Sorghum, amber	55	50	2,750
Sorghum, kafir	50	50	2,500
Sudan grass	120	25	3,000
Sweet vernal grass	1,600	2	3,200
Tall oat grass	330	10	3,300
Timothy	2,500	2	5,000
Turnip	340	10	3,400
Velvet grass	2,500	2	5,000
Vetch, hairy	36	100	3,600
Vetch, spring	19	100	1,900
Western rye grass (Agropyron)	330	10	3,300
Wheat	25	100	2,500

DIAGONAL DISTANCES BETWEEN TREES

Distances of planting (1)	Distances on the diagonal			
	Square planting (2)	Alternate planting (3)	Quincunx planting (4)	Hexagonal planting (5)
18 x 18	25.5	20.1	One-half the distances given in column 2.	All trees equidistant. Same as column 1.
20 x 20	28.3	22.4		
22 x 22	31.1	24.6		
25 x 25	35.3	27.9		
27 x 27	38.2	30.2		
30 x 30	42.5	33.5		
35 x 35	49.5	39.1		
40 x 40	56.6	44.8		
50 x 50	70.7	55.9		
60 x 60	84.9	67.1		

TABLE OF WEIGHTS OF COMMODITIES.

Commodity	Unit	Approximate net weight
		Pounds
Alfalfa seed	Bushel	60
Apples, fresh	..do.	48
	Barrel	140
Apricots	Bushel	48
Western	Crate	22
Barley	Bushel	48
Beans:		
Lima, dry	..do.	56
Other, dry	..do.	60
Blackberries	24-quart crate	36
Bluegrass seed	Bushel	14-30
Buckwheat	..do.	48-52
Butter	Tub	63
Cabbage	Western crate	85
Cherries:		
With stems	Bushel	56
Without stems	..do.	64
Clover seed	Bushel	60
Corn:		
Ear, husked	..do.	70
Shelled	..do.	56
Green, sweet	..do.	35
Meal	..do.	50
Cotton	Bale, gross	500
	Bale, net	478
Cowpeas	Bushel	60
Cream, 30-percent butterfat.	Gallon	8.43
Eggs, average size	Case, 30 dozen	45
Flaxseed	Bushel	56
Grain sorghums	..do.	56 and 50
Grapefruit:		
Florida	Box	80
California	..do.	60
Grapes	Bushel	48
Eastern	12-quart basket	18
Western	4-basket crate	20
Lemons, California	Box	76
Lettuce	Western crate	75
Milk (specific gravity 1.032).	Gallon	8.6
Millet	Bushel	48-50
Oats	..do.	32
Oranges:		
Florida	Box	90
California	Box	70

Commodity	Unit	Approximate net weight
		Pounds
Orchard grass seed	Bushel	14
Peaches, fresh	..do.	48
Peanuts, unshelled:		
Virginia type	Bushel	22
Runners, southeastern	..do.	28
Spanish	..do.	30
Pears	..do.	50
Western	Box	46
Peas:		
Green, unshelled	Bushel	30
Dry	..do.	60
Pineapples	Crate	70
Plums and prunes	Bushel	56
	Crate	20
Potatoes	Bushel	60
	Barrel	165
Quinces	Bushel	48
Raspberries	24-quart crate	36
Rice:		
Rough	Bushel	45
	Barrel	162
Milled	Pocket	100
Rye	Bushel	56
Sorgo seed	..do.	50
Soybeans	..do.	60
Soybean oil	Gallon	7.5
Strawberries	24-quart crate	36
Sudan grass seed	Bushel	40
Timothy seed	..do.	45
Tobacco:		
Maryland	Hogshead	600-800
Virginia fire-cured	..do.	1,050-1,350
Kentucky and Tennessee fire-cured	..do.	1,350-1,650
Cigar leaf	Case	250-365
	Bale	150-175
Tomatoes	Bushel	53
Velvetbeans (hulled)	..do.	60
Vetch	..do.	60
Walnuts	..do.	50
Wheat	..do.	60

Taken from: Approximate or Average Weights of Various Commodities and Other Conversion Factors, Separate from Agricultural Statistics, 1938, United States Department of Agriculture.

The weights given in this table are approximate or average, and hence not all of them are recognized as legal weights in all of the States.

SYSTEMS OF THINNING[1]

System of planting	Method of thinning	Reduction in number of trees	Form of planting after thinning	Remarks
Square	Alternate rows	50%	Rectang.	Relieves crowding in only one direction.
	Alternate rows both directions.	75%	Square	Usually too severe. Too few trees left.
	Alternate diag. rows or alternate trees in each row.	50%	Quincunx	Most common method. Remaining trees well spaced.
Rectang.	Alternate rows	50%	Square	Trees quickly crowd in one direction.
Quincunx	Alternate rows or removal of tree in center of square.	50%	Square	Best method with double planting to secure even distribution.
Hexag.	Alternate trees in alternate rows or tree in center of hexagon.	25%	Hexag.	Thinning too light to be of great value.
Hexag.	Alternate tree in each row or alternate diagonal rows.	50%	Irreg. diag.	Relieves crowding in only one direction.
	Alternate rows either on the square or diagonal and alternate tree in remaining row.	75%	Square or triang.	Satisfactory with large, thrifty, long-lived trees which will satisfactorily utilize space. With smaller, weaker trees, thinning, too severe.

[1] Univ. of Calif. Col. of Agr. Bul. 414.

ORCHARD PLANTING

Number of Trees per Acre

Distance apart	*Square planting*	*Hexagonal planting*	*Quincunx planting*
16 x 16	170	196	303
18 x 18	134	154	239
20 x 20	108	125	129
22 x 22	90	104	148
24 x 24	75	87	132
25 x 25	69	80	125
26 x 26	64	74	114
28 x 28	56	64	100
30 x 30	48	55	85
32 x 32	43	49	76
33 x 33	40	46	71
35 x 35	35	41	65
40 x 40	27	31	48
45 x 45	22	25	39

Suggestions on Orchard Planting, by Roy E. Marshall, page 8.
Michigan Agricultural Station Regular Bulletin No. 262.

Relation of size of herd to diameter of silo for summer feeding, on the basis of 40 pounds of silage per cubic foot and the removal of 3 inches of silage daily to avoid spoilage

Inside diameter of silo (feet)	*Volume per foot of depth*	*Amount to be removed— Daily*	*For a feeding period of— 30 days*	*45 days*	*60 days*	*Animals that may be fed with a daily allowance per head of— 30 pounds*	*20 pounds*	*15 pounds*	*10 pounds*
	Cubic Feet	*Pounds*	*Tons*	*Tons*	*Tons*	*Number*	*Number*	*Number*	*Number*
10	78.5	735	12	18	24	26	39	52	78
11	95.0	950	14	21	28	31	47	63	95
12	113.1	1,131	17	25	34	33	56	75	113
13	132.7	1,327	20	30	40	44	66	88	132
14	153.9	1,539	23	35	46	51	77	102	154
15	176.7	1,767	27	40	54	59	88	118	177
16	201.0	2,010	30	45	60	67	100	134	201

Silos Types and Construction, by J. R. McCalmont. U. S. Dept. of Agr. Farmers' Bull. No. 1820. Page 5.

Relation of size of herd to diameter of silo for winter feeding, on the basis of 40 pounds of silage per cubic foot and the removal of 2 inches of silage daily to avoid spoilage

Inside diameter of silo (feet)	*Volume per foot of depth*	*Amount to be removed— Daily*	*For a feeding period of— 180 days*	*240 days*	*Animals that may be fed with a daily allowance per head of— 40 pounds*	*30 pounds*	*20 pounds*	*15 pounds*
	Cubic feet	*Pounds*	*Tons*	*Tons*	*Number*	*Number*	*Number*	*Number*
10.......	78.5	524	47	63	13	17	26	35
11.......	95.0	634	57	76	16	21	31	42
12.......	113.1	754	68	90	19	25	37	50
13.......	132.7	885	80	106	22	29	44	59
14.......	153.9	1,027	92	123	25	34	51	68
15.......	176.7	1,178	106	141	29	39	59	78
16.......	201.0	1,340	120	161	33	44	67	89
17.......	227.0	1,513	136	182	38	50	75	101
18.......	254.5	1,696	153	203	42	56	85	113
20.......	314.2	2,094	188	251	52	70	104	139

Silos Types and Construction. U. S. Dept. of Agr. Farmers' Bull. No. 1820 Page 4.

CAPACITY OF CYLINDRICAL SILOS

Capacity of silos with different diameters and depths of silage[1]

Depth of silage (feet)	*Capacity with an inside diameter of— 10 feet*	*11 feet*	*12 feet*	*13 feet*	*14 feet*	*15 feet*	*16 feet*	*17 feet*	*18 feet*	*19 feet*	*20 feet*
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
20..............	27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22..............	30	37	.....	.....	.....	.....	.....	.....	.....	.....	.....
24..............	24	41	49	.....	.....	.....	.....	.....	.....	.....	.....
26..............	38	46	55	65	.....	.....	.....	.....	.....	.....	.....
28..............	43	52	61	72	84	.....	.....	.....	.....	.....	.....
30..............	47	57	68	80	92	106	121	.....	.....	.....	.....
32..............	51	62	74	87	100	115	131	148	.....	.....	.....
34..............	56	67	80	94	109	125	142	161	180	.....	.....
36..............	.....	73	86	101	117	135	153	173	194	216	.....
38..............	.....	.....	93	109	126	145	165	186	209	233	258
40..............	.....	.....	100	117	135	155	177	200	224	249	276
42..............	.....	.....	.....	124	144	165	188	212	237	264	293
44..............	.....	.....	.....	.....	152	174	198	224	251	279	310
46..............	.....	.....	.....	.....	.....	184	209	236	265	295	327
48..............	.....	.....	.....	.....	.....	.....	220	248	279	310	344
50..............	.....	.....	.....	.....	.....	.....	.....	261	293	326	361

[1] Capacities given are for normal corn silage when the silo is filled at the average speed of 20 to 50 tons per day with 1 man in the silo and refilled once after silage has settled.

Silos Types and Construction, by J. R. McCalmont. U. S. Dept. of Agr. Farmers' Bull. No. 1820. Page 5.

ERADICATING TUBERCULOSIS

On December 2d, 1940, the Bureau of Animal Industry announced that not more than one cow in 300 in any part of the United States, was tuberculous, and that for the complete extermination of bovine tuberculosis little further was required but vigilance and a mopping-up procedure to locate the few diseased cows that had thus far escaped detection.

The full significance of that announcement was not at once apparent. The public had no clear conception of its bearing on human health. The connection between the bovine and human forms of this greatest of all afflictions of man and beast was too often thought of as just another of the academic controversies of medical science. But to many sanitary officials and practicing physicians, who appreciated the proportions of the 40-year campaign that had removed the curse of tuberculosis from the dairy herds of the country, that achievement suggested the possibility of a nation wide attack on tuberculosis in man.

At first the size and cost of such a program seemed appalling. The X-ray chest films taken at induction centers, war industry plants, privately owned manufacturing establishments and at Federal civil service headquarters, covering over 10 percent of our total population, indicated that at least 1,700,000 persons were tuberculous. Fluoroscopic chest examinations in Chicago showed that about 600,000 cases a year of active pulmonary tuberculosis came under medical treatment for some other disease, not aware that they were tuberculous. X-ray chest tests in Philadelphia showed an apparent increase of 75 percent of infection over the previous year, disclosing thousands of cases heretofore not reported, and indicating that there are about as many persons suffering from tuberculosis but not receiving medical care as are reported to the public health officials.

Further experience soon demonstrated beyond the shadow of a doubt that the initial stages and often the advanced cases of tuberculosis could be discovered only by the use of the X-ray, and that the amplitude of any plan for eradicating the disease reached twice the proportion that would have been assumed from the study of previous vital statistics.

Some encouragement was found in the fact that during the past 40 years the death rate from this disease has been quartered, partly as a result of better diet and better housing conditions. But the death rate was still frightful, over 60,000 a year from tuberculosis. The total war casualties were a sad enough record to contemplate. But the 1,700,000 cases of tuberculosis presented a still gloomier picture of persons infected with a chronic disease, usually of long duration at best and with the outcome always uncertain.

And a large proportion of the deaths from tuberculosis occur in men in their most productive work years and in women during the normal child-bearing period. Half of all the deaths from the white plague occur between the ages of 20 and 45. One out of every six deaths in men and women between 20 and 35 is due to tuberculosis, which thus achieves the rank of first and chief killer of the parents of the coming generation in the very flower of their life.

The losses caused by tuberculosis seemed beyond calculation. With 850,000 or more men and women in their most productive years sentenced to a premature death or at least disability, with the mounting expense of hospitalization, extra demands for nurses and doctors, with the treatment and disability awards for tuberculous veterans of the last war running into hundreds of millions of dollars annually, and an incomparably heavier load to come from the present war, it was plain that this drain on the human life and economic resources of the country must be stopped.

This little tubercle bacillus was killing and maiming more people than the hundreds of billions of dollars' worth of military implements of murder operated by millions of men specifically trained for the purpose of killing. So the eyes of sanitary officials were turned toward the veterinarians to ascertain just what they had accomplished in the campaign for the eradication of bovine tuberculosis, and whether any of the methods used in that crusade might be applied in curbing the white plague in man.

That it was to be hard battle was evident from the start, a battle not only against the entrenched position of tuberculosis in the dairy herds throughout the country but also against a doubt in the minds of the majority of the medical profession that the disease could be transmitted from animals to man, as well as against the natural resistance of many dairymen to any newfangled scheme of interference with their business, which in

IN THIS APPARENTLY HEALTHY HERD 75 PER CENT PROVED TO BE TUBERCULOUS

turn was supported by the inertia of public opinion toward change of any sort.

The first step of course was to perfect an absolutely reliable test, one that would not miss a single tuberculous cow and would not affect a healthy one. For this purpose tuberculin was chosen, a by-product of the growth of tubercle bacilli. Dr. Dorset had been experimenting with this material since 1900 with varied success and disappointment till 1917, when such perfection had been reached that two drops injected into the skin would promptly and unfailingly show whether or not the animal was infected with tuberculosis. Then and not till then could the crusade begin with hope of success.

Even so it required an almost quixotic confidence and enthusiasm to enter the list against tuberculosis. The universality of the disease was enough to give one pause. It had persisted without check since the early dawn of history in every civilized country, in all latitudes from the polar regions to the equator, at all elevations from sea level to mountain top. No race of man was exempt. The whole gamut of warm blooded animals was affected,—cattle, hogs, horses, sheep, goats, poultry, dogs, cats, deer, elk, zoo denizens from apes to zebras, caged birds, rats, mice.

Plainly the disease was ubiquitous. There was no clean spot on earth. But a start had to be made somewhere to break the chain of intertransmission of the plague between man and all the animals with which he comes in contact. Quite naturally, therefore, the Bureau chose the dairy cow, partly because the milk of tuberculous cows was known to transmit the disease to human beings, especially to children, and because milk occupies such an important place in the human diet from childhood to old age. To be able to guarantee the wholesomeness of that product would add to the peace of mind of millions of milk consumers. The job in hand, therefore, resolved itself into the specific task of eradicating tuberculosis in dairy cows.

Even simplified to that extent it was quite a sizable undertaking. There were 25,000,000 of those cows unevenly distributed in the 3,000 counties of our 48 States. So the game was to find which cows were infected and then to dispose of them with due consideration of the rights of the dairy farmer. Obviously the diseased cows must be eliminated. No good purpose could be served by merely determining how many sick cows we had as a matter of statistical information. Every cow that reacted to the tuberculin test must be slaughtered. Otherwise she would continue to be a source of further spread of the disease.

But as the testing began occasional herds were found in which 75 percent of the cows were diseased. To ease the burden of loss upon such unfortunate dairymen a system of indemnities was set up in which the Federal, state and county governments participated, the indemnity varying according to the value of the part of the carcass that could be salvaged.

Then things began to happen as a result of the head-on clash of opinions, part of the trouble being inherited from previous unsuccessful attempts to cure the disease. Dr. Robert Koch, the discoverer of the tubercle bacillus in 1882, in an experiment he made a few years later believed he had obtained evidence that the disease could not be transmitted from cattle to man. If that were true why worry about the milk of tuberculous cows. Koch's statement precipitated a hot battle in the bacteriological camp in which he came off loser. But the idea had taken root in the minds of many physicians who lent their authority in support of those dairymen who opposed the testing of their cows.

Determined resistance, backed up with threats of violence was offered in Pennsylvania, South Dakota, California and Iowa. In Iowa the objectors called a general meeting. Dr. J. A. Myers reported that a member of a farmers' organization urged the dairymen "carry your pitchforks to Des Moines. I dare the militia to lay hands on you fellows. If that should happen there will be a revolution and 100,000 farmers will be in Des Moines next morning to clear out the State House." The embattled farmers of Iowa received perhaps more publicity than any other group, but individuals here and there gained considerable notoriety by their antics before the tuberculin brain-storm subsided.

The urgency of pushing the program forward with all possible speed called for patience and diplomacy on the part of Dr. Mohler, his staff and a corps of official and private veterinarians. Together they smoothed the ruffled feathers of the opposition, explained the nature of the disease, the purpose of the campaign in detail, and the benefits to flow from it to the dairyman and to the milk consumer. But even all their efforts might have come to naught if the tuberculin had not given evidence of its reliability and accuracy beyond dispute.

This diverting episode in the early history of the campaign had one beneficial effect that greatly facilitated the progress of the work from that day to this. All doubt of the accuracy of the test and of the intentions and scientific competence of the men in charge of the crusade disappeared. That eliminated one hurdle in the pathway to victory.

There was still a lingering doubt in the minds of most physicians as to the bearing of the work on human health. Dr. Charles H. Mayo, however, and a few other prominent medical men came out strongly for the continuance of the campaign. Gradually opposition broke down as specific evidence accumulated to prove the bovine origin of a considerable percentage of the cases of tuberculosis in man.

Thus during the long and often discouraging struggle constant efforts were directed toward educating the public in the methods and ultimate aims of a scientific crusade for healthy cows and sanitary milk.

The men who had carried forward this unparalleled sanitary campaign for 25 years during which over 265,000,000 tests were made, often covering 25,000,000 cows in a single year, gaining control of disease that had been a veritable scourge of the dairy industry and the direct source of four to fifteen percent of tuberculosis in human beings, could rightly speak with authority on the subject while without undue boastfulness calling attention to the bearing of the results on various domains of human economy.

With the slaughter of all reacting cows and the consequent elimination of just so many different sources of further infection, (the number to date exceeds 4,000,000) it was noted that from 1917 the percentage of cases in man declined correspondingly. At one time whole hospital wards were filled with tuberculous children, pitiable victims of contaminated milk from diseased cows. Fortunately such sights are no longer to be seen. Children are particularly susceptible to the infection and the disease runs a more rapid and more often fatal course than when acquired in later years. About half the cases of tuberculosis in human beings traceable to infected milk take the pulmonary form, but children are more likely to be afflicted in the bones, lymph glands and intestines.

The problem of a safe milk supply received expert attention from another direction by the Bureau of Animal Industry. It was found that milk may be rendered perfectly safe to drink by pasteurization if in that process it is heated to a temperature of 145 deg. F. for 30 minutes. All tubercle bacilli are surely destroyed by such treatment. But in many instances the pasteurization apparatus was not in perfect order and failed to develop the required temperature. Pressure was at once brought to bear in correcting such deficiency.

Following those disclosures a survey of market milk supplies to determine what percentage of it was actually pasteurized at all in towns and cities of various sizes showed that about 25 percent is pasteurized in towns of 1,000 to 2,500 people, 41 percent in towns of 2,500 to 5,000, 49 percent in places of 5,000-10,000, 58 percent in places of 10,000 to 25,000, 73 percent in cities of 25,000 to 100,000, 86 percent in cities of 100,000 to 500,000 and 96 percent in cities of 500,000 or more.

Apparently somewhat more than 2,000,000 milk consumers are still unprotected from infection by reason of the lack of facilities for pasteurization. There is room for improvement in that direction, particularly since it has been calculated that loss of working time and cost of medical treatment due to milk-borne diseases alone run beyond $2,800,000 annually. Incidentally our veterinarians called attention to the consideration that if not a single cow or goat or any other animal whose milk is used for food were tuberculous, it would still be advisable to pasteurize milk. We need only remind ourselves that the so-called Bang's disease of cattle, the cause of the treacherous undulant fever in man, is yet quite prevalent, though the Bureau of Animal Industry is already on its trail with an organized campaign of total war. Speaking only for myself, after watching the processes of milking, handling, cooling and bottling milk I should always prefer to have it pasteurized for the simple reason that there are so many chances along the way from the cow to the bottle for some unlovely bacteria to gain entrance unnoticed.

The private family cow has often brought disaster to those who drank her milk without pasteurization. There was the notorious case of a cow that transmitted tuberculosis to all the seven children of the family as well as to her calf and to a venturesome pig that poached upon the calf's domain. The family was loath to believe their cow to be the culprit. She hadn't recently associated with

other cows. Yet she was in an advanced stage of tuberculosis, the udder being literally riddled with the disease.

Dr. J. A. Myers who followed the eradication work in cows was able to announce authoritatively that 50 percent of cases of tuberculous glands in man were due to infection from cattle and that fully half the cases of lupus skin ulcer in man were of bovine origin as well as at least 20 percent of the infection in the bones and joints in man. These forms of the disease in human beings show a significant decline since the inception of the campaign with dairy cows. Evidence in this direction couldn't easily be missed in the case of such a conspicuous deformity as the hunch back condition most of which was caused by infection of bovine source in the bones of the spinal column.

As evidence of the benefits of the campaign accumulated on every hand the movement gained momentum. News spread from the areas that had been cleaned up and pronounced free from tuberculosis. No more sick cows for me became the motto of the farmer. In buying cows to replace those that had been slaughtered he required a certificate of inspection and tuberculin test with every cow.

Rivalries between counties arose in a free for all race for the cherished certificate of accredited status as free from the dread plague. And when a county was added to the rapidly expanding clean territory, public meetings were held for jubilation over the joyous event. Not alone the dairymen rejoiced for whom the benefits of the campaign ran up to millions of dollars. But milk consumers, especially the parents of young children, and the public generally caught the contagious enthusiasm of the veterinary inspectors who after patiently testing millions of cows year after year could now see the goal within reach. An occasional disbeliever bobbed up and heatedly maintained that man had nothing to fear from the milk of diseased cows. Even Senator Carter Glass joined that little chorus with his booklet on "The Tale of Two Heifers." But these voices were drowned out in the cheers of the accredited counties waving their certificates of cleanliness.

As the movement swept irresistably onward, reinforced at every step by the voluntary assistance of farm organizations, women's associations, county and state health agencies and leading medical authorities, it could no longer be confined within the bounds of its original purpose to eradicate tuberculosis among dairy cows. The idea itself was contagious. The first goal having been reached, where do we go from here was the query.

The answer was not far to seek. It began to take shape in the formulation of an all-embracing crusade for the total eradication of tuberculosis in man, cattle and other animals. Tuberculin was tried as a test for detecting the disease in man but was soon rejected because it sometimes caused a flare-up of the infection in those who were already victims of the plague. But on an X-ray film the slightest beginning of a tubercle in the lungs was recorded. Not only at induction stations were millions of young men X-rayed and all cases of tuberculosis segregated, but workers in war plants were similarly tested.

Two years ago the Civil Service Commission began subjecting to X-ray tests all newly appointed Federal employees in the District of Columbia and the test has been extended to include all Federal employees in Washington. The idea took wings and spread to private corporations. The American Brake Shoe Company, for example, with 59 plants in 23 States and Canada, began X-raying the chest of every employee, the results of the tests being communicated to each individual, with recommendation in positive cases that the family physician be consulted. This practice is extending in all directions throughout the country.

The wider the adoption of the X-ray test became, the more encouraging were the results of its application. The unusual susceptibility of young children to tuberculosis and the high mortality rate among them had for long been the despair of practicing physicians. But heretofore the disease could not be detected till so far advanced that a cure was always doubtful. By X-ray the infection could be caught at its very beginning, and experience demonstrates that prompt hospital treatment saves a large percentage of such cases. In fact for all ages the earlier the diagnosis the shorter the treatment required, the lower the death rate, the smaller the likelihood of spreading the infection and the less the economic loss to the individual in enforced rest and long medical treatment.

Heretofore doctors had been seriously handicapped in that tuberculous patients came to them for treatment only after pronounced symptoms had developed and the best chance for a cure had passed. For tuberculosis when once developed far

enough to show recognizable symptoms is a protracted disease at best. Even after a cure the patient may not always safely go back to his former line of work which perhaps caused the infection in the first place. He must often find new work and overcome the fear and ostracism of his community. Much of the human wreckage left in the wake of a tuberculosis infection discovered too late was therefore beyond redemption.

Here again were lessons to be drawn from the work on dairy farms. In cleaning up infected premises the popular belief in fresh air and sunshine received substantial verification. The tubercle bacillus may live and thrive a long time in filth, but when exposed to fresh air and sunshine in the open it has only a short shrift.

As was the case with the progress of the campaign in cleaning up dairy herds, so with the incipient concept of a national fight against human tuberculosis the first operations were on a small scale or to meet specific emergencies. Some States were far ahead of others in tackling the problem. Minnesota has been in the vanguard for many years. Forty civic agencies in that State, according to Dr. E. A. Meyerding, in cooperation with local physicians had reduced the death rate from tuberculosis by 75 percent since 1907. Minnesota was the first to adopt the accredited herd plan for control of bovine tuberculosis, and now heads the list of States with a project of State-wide control of the disease in man. For accreditation counties must show a death rate below 10 per 100,000 population. Ten counties are already on the honor roll. The Health and Tuberculosis Association of St. Louis County in 1943 began X-ray examination of every person in the county. Other counties are not far behind. The complete eradication of tuberculosis within the State is confidently announced as to be expected within 10 years, perhaps sooner.

In view of the favorable results from the prompt treatment of tuberculosis made possible by X-ray tests and the cordial cooperation of the public as these new methods became known, it was not surprising that a general demand was manifested for the consolidation of these efforts into a Federal agency to carry the movement for the emancipation of man from the incubus of tuberculosis into every community of the 48 States.

Congress soon yielded to the pressure for the creation of such an agency. In the Public Health Service Act of July 3, 1944 provision was made for the establishment of a Tuberculosis Control Division with an appropriation of $10,000,000 to "develop more effective measures for the prevention, treatment and control of tuberculosis." Dr. Herman E. Hilleboe has been named chief of this Division. For the future the program involves X-raying the entire population, periodic re-examinations of persons with latent or inactive tuberculosis, treatment of active cases and isolation of "open" pulmonary, coughing cases. While the immensity of the task is not underestimated Dr. Hilleboe is confident that "with the Public Health Service, State health authorities and the National Tuberculosis Association and its affiliates working side by side in a joint enterprise, a national program can be carried out that will not only bring tuberculosis under control but will eradicate it."

And the end is not yet. At its last annual meeting the American Medical Association passed a resolution urging the creation of a National Department of Health with full cabinet status. Whether or not that would be the best solution of the matter it is too early to say, but it may be taken as another straw in the wind indicating the vitality and persuasive potency of the idea behind the movement to exterminate bovine tuberculosis. As that campaign neared completion it took on a somewhat different character. A large percentage of the dairymen became so thoroughly convinced of the soundness of the tuberculin test and the importance of possessing a clean herd of cattle that they voluntarily employed private veterinarians of recognized standing to make periodic tests of their cows, thus relieving the Federal authorities of a considerable part of the burden. Perhaps a similar development will take place in the battle with human tuberculosis. In 800,000 cases X-rayed by the Public Health Service 62 percent were in the beginning stage when cure is almost certain with good care, whereas in the past only 10 percent of the patients who presented themselves for treatment were in the early state of the disease. As the movement sweeps on in its course, especially if accompanied with a vigorous educational campaign, parents may include an annual chest X-ray test of their children as a regular feature of the family health program.

But tuberculosis is on the way to its final exit. Twenty-two States already have officials on full time in their set-up

for control of tuberculosis. The Public Health Service has established consultation offices for private industries in 38 States to assist them in the prevention and treatment of tuberculosis among their employees.

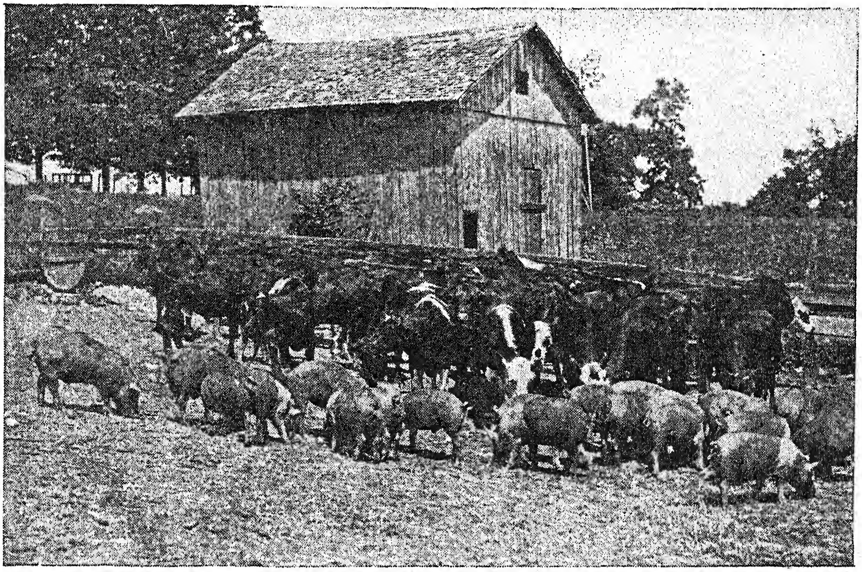
And while trying to visualize the extent of popular interest in better health it should be borne in mind that with the eradication of bovine tuberculosis the Bureau of Animal Industry has not left the field of battle. There are hogs and poultry to consider. Human beings, cattle and hogs down through the centuries have been busily transmitting the infection to one another in an unending sequence of losses and tragedies. It is comforting to know, however, that the eradication of the disease in any one of the four species of carriers renders it correspondingly easier to put an end to the trouble in the other three. Fortunately the disease in hogs and chickens is largely confined to the central corn belt where these animals associate closely with cattle and may have become infected from the excretions of tuberculous cows.

When the last tuberculous cow walks down the chute to the oblivion of the slaughter house, hogs and chickens may frolic about the farmstead without fear of tuberculosis and we may drink our milk and eat our pork sausage and chicken livers in comfort and confidence.

That happy day may not be so far off. The Bureau of Animal Industry with its large corps of veterinarians in active cooperation with dairy and other livestock and poultry associations, county agents and private veterinarians in every county in the land is hot on the trail of any remaining cases of tuberculosis in cattle, hogs and poultry.

And now comes the gargantuan project of the Public Health Service, armed with authority and $10,000,000 a year to be used in cooperation with State, county and local health associations and practicing physicians for the control and ultimate elimination of tuberculosis in man. A score of years ago it would have appeared quixotic to expect even such an army of trained crusaders to reach their goal in any short span of years.

But meanwhile new techniques of combating tuberculosis have been devised. Tubebrculin and the X-ray film as means of detecting the disease have been refined to an almost perfect accuracy and dependability. New and more efficient curative treatments have been elaborated. But the most hopeful sign of all is the willing cooperation of the public after a long struggle with suspicion and opposi-



HOGS MAY BECOME INFECTED BY RUNNING WITH CATTLE

tion. Now people gladly come to be X-rayed because they want to know the truth about their condition of health. And they come in time to make recovery from a possible recent infection a matter of short duration with a minimum of expense or loss of time. Likewise farmers recognize that it is to their interest to have every tuberculous cow detected and disposed of in fairness to all concerned. Perhaps the hope expressed in Minnesota of reaching the goal within ten years is not too optimistic. Government agencies started the movement. The people have decided to finish it. It's a job for each one of us. Health is a personal matter that comes home to roost on the bed post every night.

INSECTICIDES

DDT, now manufactured extensively by several firms, has proved to be almost unbelievably effective against mosquito wigglers even in a dilution of one part per 100,000,000 in ponds. Even dusted by means of airplanes it may exterminate mosquitoes. Against various other insects it is equally effective. But the early publicity it received as being quite harmless to man and other animals has proved too optimistic. Entomologists now caution against its indiscriminate application. It is poisonous to man if the powder accumulates on fruit and if used in a wholesale manner it kills bees and various other useful insects.

Pyrethrum production is an important industry in Kenya Colony, east Africa, with an annual output of 3000 tons. Increased demand for this product has led to larger plantings in various parts of Latin America and elsewhere.

PALM OIL

About 25,000 tons of this oil is imported yearly for use in food and soap manufacture and unguent for hair and skin. The chief centers of production are West Africa and Malaya. An extensive use for palm oil is also found in tin manufacture. The oil prevents rust and tarnish of tin plates. It is rubbed from tin plate with bran and the resulting mixture is used for cattle feed.

MILK GOATS

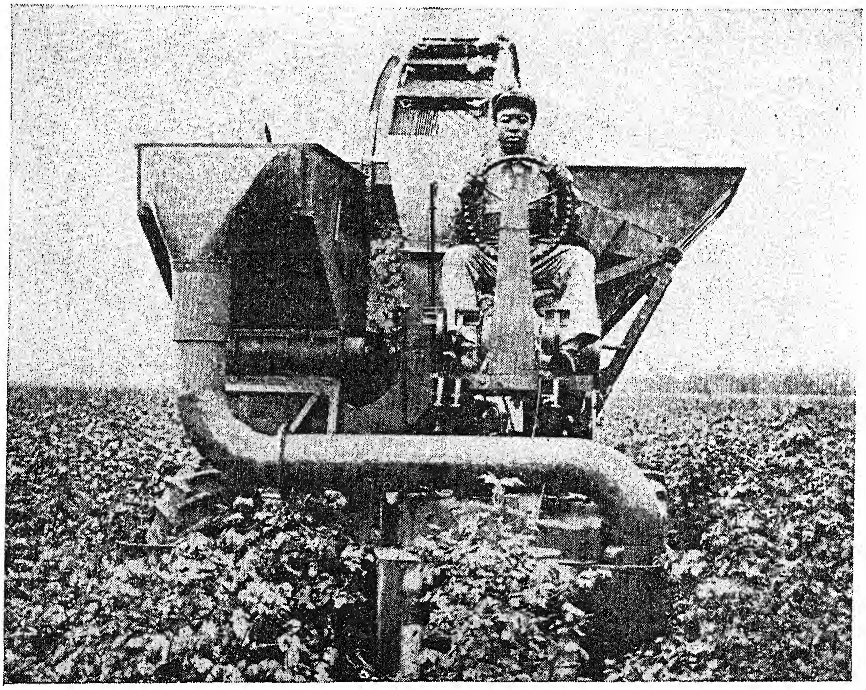
Numerous tests of the properties of goats' milk have been made at the New York Experiment Station, Johns Hopkins University, Beltsville Research Center and elsewhere. In general it has been found that the milk is characterized chiefly by the small size of the fat globules. On this account the cream does not rise by standing but remains rather evenly distributed through the milk. In a series of feeding tests with infants at Johns Hopkins "No essential differences in health, general appearance and well being of the infants were observed between those fed on the milk of Jersey or Holstein cows and goats' milk." Many special cases however, have been reported in which children that did not thrive on other food showed marked improvement on a diet of goats' milk.

Analyses made at the Beltsville Research Center showed a lower percentage of total solids, fat, protein and milk sugar in goats' milk than in the milk of Jerseys or Holsteins. No significant differences were found between goats' and cows' milk in the percentage of lime, iron, phosphorus and copper. Goats' milk in tests at Johns Hopkins contained less vitamin A. and more vitamins B_1 and G. than did Jersey milk.

In the Beltsville experience with goats three quarts a day is considered an excellent yield. But the yield varies greatly according to the breed and conditions from two quarts a day up to a record of 4162 Lbs. in nine months by a doe of the Saanen breed in California. The demand for goats' milk is gradually increasing, one reason being that goats are rarely affected with tuberculosis, a matter of much importance in the feeding of infants, and another being the usual sturdiness of goats.

COTTON

Looking ahead with cotton implies a preview of a revolutionary change of scene. The practical mechanical cotton picker is in the field at last. With the motorized picker in the old South and the stripper in the western part of the cotton belt, hand picking will gradually be relegated into the class of scythes, ox-carts and hansom-cabs. Last season on many commercial cotton plantations all operations from planting and thinning to picking were done by machine.



MECHANICAL COTTON PICKER IN OPERATION

Ultimately this development may be expected to displace 4,000,000 or more negro and white share-croppers at present on small cotton farms. That in turn will present a problem of unemployment and necessitate the absorption of these farmers into industrial occupation in the South or North.

Not only is cotton production destined to be mechanized but cotton is already migrating westward. This shift to the west means less cotton in the old South and increasing acreages in Texas, Arkansas, Oklahoma, Arizona, New Mexico and California. This migration is forced upon King Cotton by stern competition both abroad and at home. Several foreign countries are raising cotton considerably below the cost of production in the United States or at least below the American cotton price. At 20 or 25 cents a pound our cotton can't compete in foreign markets. Nor is competition met alone on the world market. At home cotton must compete with nylon, rayon, soylon, vinyon, casein fiber and other synthetics. It seems doubtful whether cotton can hold a price above 8 or 10 cents a pound in open competition with its rivals. These fibers are making good in every use in which cotton is adapted. About 20 per cent of motor tires are made with rayon. For bagging paper is a strong rival, and also for facial tissues, napkins, towels, etc. For bags it's a close race between cotton, jute and paper.

In this contest cotton has been losing in recent years for several reasons. Cotton farms are in most cases too small for economic operation. This fragmentation of our cotton area into tiny patches

makes it practically impossible to raise the grade or cleanliness of the fiber. The trash is not excluded. The cotton is too often not picked before it suffers damage from rain. And the better grades are not always kept separate. For these and other obvious reasons the grade of American cotton has been tobogganing downward since 1930.

The present outlook is in favor of plantations rather than small farms. The variety to be planted and the cultural details of growth and harvesting may then be better standardized.

For a long time, probably indefinitely, good cotton land will naturally stay in cotton. But much land now in cotton will go for use as pasture, food crops for man and feed crops for live stock. We have already reached a point where population pressure on this cultivatable land areas is being keenly felt. From now on we may have to curtail the acreage of cotton and tobacco in order to step up food production for our growing population. In fact within the cotton belt proper about 8,000,000 acres have been taken from cotton production for use in raising food. It is already hard to justify the use for growing cotton of any land not capable of yielding a bale or better per acre. Cotton in plantation size areas and on fertile land will be in position to weather the ups and downs of economic cycles and to hold the rank of a major farm crop as heretofore.

Some of the poor, eroded sidehill patches where a bare existence is eked out by a share cropper with a quarter or half bale of cotton may well be used in producing pulp wood, fuel and other forest products.

REDWOOD BARK

Among the unique attractions in California the giant sequoias or redwoods are certain to be remembered by every visitor in that state. Redwoods as forest patriarchs and as sources of high grade lumber are sufficiently familiar. But recently a practical use for the bark has been found. On the oldest trees the bark may be eight to twelve inches or more thick. The mere fact that many redwood trees have weathered the winds and storms for 4,000 to 5,000 years during which untold surface fires have raged over the forest floor, demonstrates that this bark is highly fireproof. It not only resists heat and cold but is also almost completely impervious to water and is not subject to rot though it may lie on the ground indefinitely. Huge piles of the bark had accumulated near the saw mills.

Other virtues in addition to its resistence to fire, water and decay have been found. The bark contains an antiseptic property that protects it against the attacks of termites, borers and other insects as well as against all manner of fungus and bacterial diseases. For these reasons the bark is ground or shredded and used as a soil amendment. It serves perfectly to loosen heavy clay soils while not in any way interfering with water drainage. The bark in fact does not absorb water. It's therefore the best means of improving the physical condition of sticky alkaline or adobe soils. Sudden changes of heat or cold are also softened in their effects upon delicate plant roots. The ground bark does not become soggy or sink into the lower layers of the soil like leaf mold and peat moss. Nor is it easily displaced or washed away like sand. Moreover its presence in the soil prevents the development of various diseases that affect garden and other crops. Scattered about the base of rose bushes it is a preventive of even such a trouble as black spot which has been almost the despair of rose growers.

SILK

In Mineral Wells, Texas, what appears to be a promising silk industry was recently started. Already 70,000 mulberry trees are supplying leaves for the silk worms hatched from millions of eggs. A new silk-reeling machine enables one worker to reel as much silk as twenty Japanese by their hand methods. Reeling the silk filaments from the cocoons has heretofore been the most tedious, labor-consuming process in the silk industry. There seems to be adequate financing for the project, and with the probable expansion of the enterprise opportunity for employment will be furnished for thousands of workers. Hosiery and other finished silk products are flowing into trade from the mills.

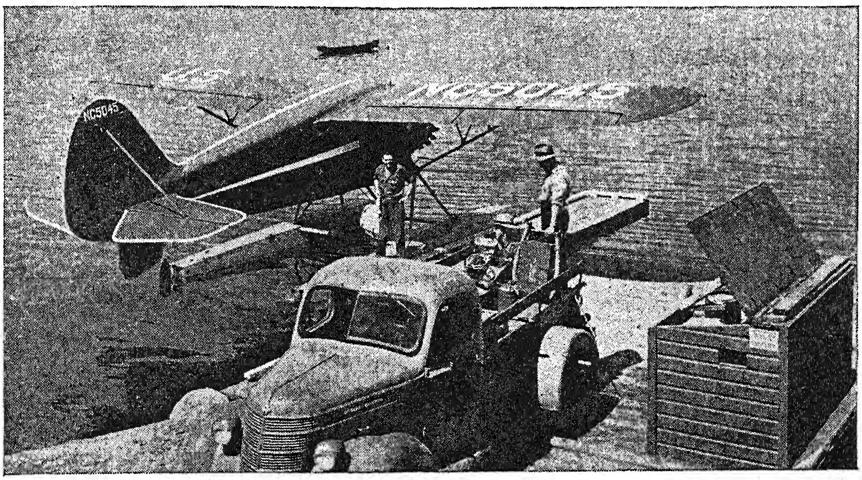
RAT POISON

A product first developed by the Du Pont Co., and recently used extensively by Drs. C. P. Richter and John Emlen of Johns Hopkins University is rapidly fatal to rats even in the minutest quantities. This powder is alpha naphthyl thiourea, antu for short. Dusted in the runways or burrows of the rats it irritates their skin and the rats lick it off with fatal results. Rats are suspicious of most poisoned baits and may not eat them. But antu obviates that disadvantage.

About two-thirds of the City of Baltimore has been freed of rats. Several whole blocks have been completely deratted and the pests do not come back. Hence it appears that a city may be cleaned up block by block.

THE AIRPLANE AS A FARM MACHINE

About 80 percent or 130,000 acres of the rice land of California is seeded from the air with excellent results. As the rice approaches maturity planes may be used as scarecrows to keep seed-eating birds away by flying low over the fields.



AIRPLANE USED IN FIGHTING FOREST FIRES

Western grazing lands are being rejuvenated by range grass seed sown from planes. Thousands of acres are thus covered in a few hours and this operation may be timed to take place just before a forecast rain, in that way insuring a high percentage of germination.

Planes find increasing usefulness for spreading insecticides on crop lands. From 300 to 500 acres per day may be dusted by one plane. Another job admirably done by planes is scouting for the detection of fires in forests and dropping parachuters as fire fighters. Finally in case of emergency farm accidents planes are of most timely importance in hastening medical help to farms and carrying the injured to hospitals.

RAMIE

Hope has been reawakened that the future of ramie may be opened wider by claims for a new invention of a machine for separating and degumming the fiber. There are at present only about 25,000 acres of the crop mostly in Texas, California, Louisiana and Mississippi. If the machinery for economically extracting the fiber proves satisfactory the area of ramie may be considerably extended in the Everglades and elsewhere along the Gulf Coast.

SUGAR CANE

One of the chief labor items in raising sugar cane is the cost of cutting the cane. The stalks of most varieties of cane lodge in various directions, the lower joints often nearly fall on the ground. Under such conditions the tangled mass of stalks made mechanical harvesting a difficult problem. In fields of the erect-standing varieties of cane grown in Louisiana and Florida a recently perfected harvester has given satisfactory results.

Cuba increased its sugar production from 2,700,000 short tons of sugar in 1941 to 5,500,000 in 1944, without the installation of any new machinery or any substantial request for fertilizers; that means without having to draw against the common resources of the United Nations. And though two successive droughts reduced somewhat the 1945 and '46 crops, Cuba is ready to equal or surpass the figure of 1944 in 1947 and '48. When all other sugar sources failed, Cuba was able to duplicate its production and to supply the world with more than 25% of its consumption at stable prices far below those prevailing in the world market.

FARM REAL ESTATE

At all times, between wars as well as during wars, there is as much speculation in the business of farming as in other industries or in the stock market. And this constant speculation bears directly upon the price of farm land. Since the beginning of the second World War as argued by the U. S. Department of Agriculture, "prices for farm commodities have doubled, in contrast to an increase of about one-fourth for other commodities. There is no reason for a permanent realignment on these levels. Because of an expansion in the capacity of agriculture to produce, and the time required for contraction a less favorable relationship compared with prewar times is quite possible. A more balanced relationship may involve a substantial downward adjustment in agricultural prices."

The price which the prospective buyer of farm land may pay, be he a farmer or a nonfarmer, with reasonable hope of a profitable return on his investment depends of course on the price of farm products. Not, be it remembered, on the prevailing price at the time of purchase but on the average price received, say, during the previous decade and the probable trend of prices for the next ten years.

That is an easy statement to make but exceedingly difficult to follow in practice. That's where the real excitement in agricultural planning comes into focus. It's a guessing game, no less a gamble than betting on the ups and downs of the stock market. Astronomers can predict when two planets will be in conjunction a hundred or a thousand years hence, and with an exactness correct to the split second. The heavens operate on a fixed schedule, not so farm prices.

To prognosticate in agriculture is a very precarious undertaking. Here we have to deal with a score or more of important factors, mostly not under human control, constantly moving under the impact of interaction among themselves. The weight of these factors changes from day to day and the rate of change varies with the season or quite unexpectedly. Moreover events in India, China or Argentina may upset the wisest calculations when all is quiet on the Potomac, or the Mississippi or the Rio Grande.

Farmers have been buying more land recently, nearly two-thirds of recorded purchases being made by farmers, and one-half of the sales for cash. About 10 percent of the sales are resales of farms bought only a year or two previously.

The factors and trends involved in the determination of farm land prices have been discussed by M. M. Regan, A. R. Johnson and F. A. Clarenbach of the U. S. Department of Agriculture as follows:—

"Land values in the longer post-war era will depend chiefly upon three factors: (1) Farm prices and incomes; (2) land earnings; and (3) interest and capitalization rates. There are, of course, a multitude of other forces that have an effect on land values: The general employment status, credit systems, domestic and foreign trade, monetary and tax policies, and changes in population. The governmental programs directly affecting agriculture such as crop control, conservation and flood control, surplus crop marketing and nutrition programs, settlement and land-development projects, tenure improvement, farm credit, and price-support efforts, all have a bearing on the land

market. Likewise the advances made in livestock and crop production through improved practices, use of fertilizers, and other technological improvements; use of agricultural products in industry; and changes affecting the costs of furnished materials and equipment needed in farming, cannot be overlooked.

"Many items in this partial list are highly interdependent and they show clearly how difficult it is to indicate the outlook for land values with any assurance. Yet buyers and sellers and borrowers and lenders are daily 'predicting' future farm prices through sales, appraisals, and loans. Although few would admit making such forecasts, farmer-buyers, investors, and all those other than short-run speculators must expect either several more high-income years or a longer-run level of farm incomes higher than those of 1910-14 or 1935-39—or they would not be purchasing land.

"In most of the important agricultural areas of the country, values are now substantially above the levels likely to be maintained by farm-commodity prices equal to those of 1935-39. In most States where values have increased as much as 50 percent from the beginning of the war, a farm-product price and land-income structure approaching that of the 1925-29 period would probably be required to maintain present levels.

"Under the rather optimistic assumption that the present general price level and reasonably full employment will be maintained, what are the probabilities of future farm-product prices and land earnings being as high as in the 1925-29 period? Several considerations point toward the probability that prices of farm commodities will be lower in relation to other prices and that a lower share of farm income will go to land. Since the beginning of the war, prices for farm commodities have doubled, in contrast to an increase of about one-fourth for nonagricultural commodities. There is no reason why the war should cause a permanent realignment in price relationships on these levels. As a matter of fact, because of the expansion in the capacity of agriculture to produce and the time required for contraction, a less favorable future relationship, compared with pre-war times, is entirely possible. Even though present general price levels were maintained, a more balanced relationship might involve a very substantial downward adjustment in agricultural prices.

"Even with reasonably full employment, the likelihood of an agricultural surplus problem at some time shortly following the war cannot be dismissed. This could happen despite foreign trade policies or broad nutritional programs that may be undertaken. It now seems that agriculture will enter the post-war period with a substantially higher acreage in cropland than will be required even under highly favorable conditions of demand.

"Many technological improvements that increase production have the effect of increasing the supply of land. Some further increase in the supply of land may be obtained through the use of fertilizer, irrigation, drainage, and clearing practices. Some of the possibilities for substituting nonagricultural for agricultural commodities in certain industrial and manufacturing uses will become more apparent as a result of the war. Farm-operating costs and returns to labor and management are likely to be higher than in the pre-war period. Such developments tend to reduce prices for agricultural commodities and returns to land.

"Except for the possibilities of a further substantial reduction in the general purchasing power of money or lower capitalization rates in the years following the war, there is little in the long-run outlook that would justify expecting land values for the country as a whole to be as high as, or any higher than, those prevailing in the summer of 1944. Some upward adjustment in a few areas may be in prospect, but in most States land values appear to be at or beyond the levels likely to be maintained in the longer post-war period.

"In the event that general commodity-price levels are not maintained and industry operates at substantially less than full capacity, material downward adjustments in prices of agricultural products would be expected. If the general price level should fall to that of 1935-39, farm land values would also tend to approximate their 1935-39 averages."

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